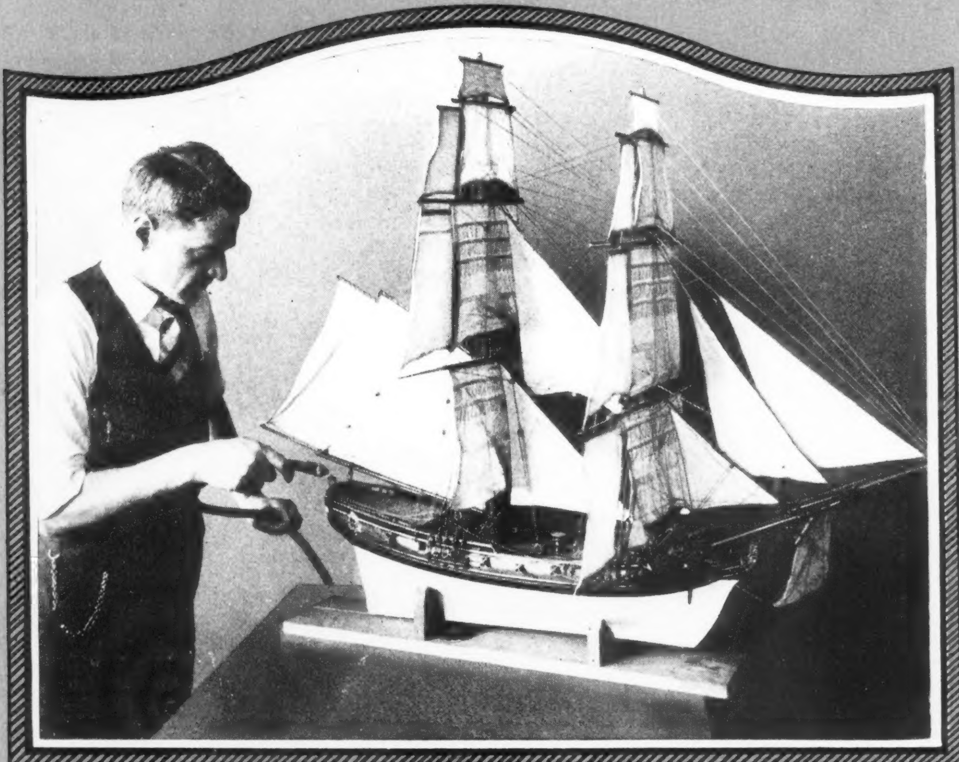
Compressed Air Magazine

Vol. XXX, No. X London New York Paris 35 Cents a Copy

OCTOBER, 1925

CIRCULATION THIS ISSUE
25,806 *COPIES*



COMPRESSED AIR IS UTILIZED EFFECTIVELY IN MANY WAYS IN A NOVEL SHIPBUILDING PLANT IN NEW YORK CITY

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Compressed Air Magazine
NEW YORK · LONDON · PARIS
Principal Offices:
BOWLING GREEN BUILDING
No 11, BROADWAY,
NEW YORK.

VOL. XXX, NO. X

OCTOBER, 1925

Unique Shipyard That Builds Miniature Craft

In This Highly Specialized Plant Compressed Air is Extensively Employed to Advantage

By A. S. TAYLOR

A SHIPYARD in a skyscraper!

This is a fact and not a flight of fancy. Instead of being located on a waterfront this particular shipyard is ten floors up above a street level threaded by a nearly ceaseless stream of vehicular traffic. We are speaking of the plant of the H. E. Boucher Manufacturing Company which is engaged in producing miniature craft of many sorts. Although the vessels so constructed are on a diminutive scale still they subscribe with exactness to the requirements of the naval architect and the marine engineer.

Measured by the number of keels and by the variety of types turned out in the course of a twelvemonth, this unusual shipyard exceeds in output that of any other shipbuilding plant in existence. The Boucher Company is headed by Mr. H. E. Boucher who has been intimately identified with work of this character for more than a quarter of a century. The present enterprise was established about 1905, and has been located on Lafayette Street, in New York City, since 1914. For some years, the company concentrated mainly upon the making of exhibition models, but latterly much of the time of its skilled personnel has been directed towards the manufacture of toy yachts which either carry sails or are equipped with power plants capable of driving them through the water at goodly rates of speed. We shall touch upon this development of the industry in due course.

The especially interesting aspect of this decidedly unique shipyard lies in the fact that its highly trained, facile-fingered workers are able to reproduce in miniature every detail of the ships of all ages and of all maritime peoples. Most of us consider ship models in the light of expensive toys or something that may be decorative but scarcely of practical value. This viewpoint is not justified; and to make this plain let us hark back several centuries and trace briefly the origin of small replicas of ocean-going craft. It will then be plain to us that usefulness had much to do with their fabrication, and the same reason holds true to a large extent now.


Dusting with a jet of compressed air the beautiful and complicated model of the famous old brig "Fair America."

In the generations gone, when Great Britain was very busy strengthening her position upon the seas, master shipwrights—not naval architects as we call them today—were the men that conceived and brought into being those "oaken bulwarks" that gave the British their start in the race for supremacy in the maritime world. At that time, the national authorities would have thought they were tempting Fate if they laid a keel and undertook to construct a ship before they had seen on a much reduced scale just how the vessel would look when finished in full size. Indeed, we are told that the ship carpenters would not have known how to go ahead with their tasks unless guided by a model finished in every essential detail. It was that practice that brought into being the myriads of models that are now to be found in the halls of the British Admiralty and in certain British museums and public institutions.

For a long while, models of that sort were the source from which working plans were prepared, and the models provided information and helped the ship carpenters and the shipwrights to visualize what they were expected to do. Not much was left to the imagination; and great care was taken to bring out every prime structural feature. Accordingly, the outside planking on one-half of the hull was omitted so that the framing, the deck beams, etc., could be seen in their true relations to one another agreeably to their different positions in the decidedly complicated framework of the vessel. On the other half of the hull, the planking would be complete from the keel to the upper limits of the bulwarks—thus making it easy for the shipwright to "take off" the lines or contours essential to flotation and to ease of propulsion when under sail. The lines measured and modeled in this manner were reproduced in full size on the mold-loft floor so

that the man with the broad-ax could fashion his timbers correctly.

One can readily see that the modelmaker became a recognized worker of the period, and, not infrequently, he was a qualified shipwright who could boast exceptional skill in the handling of rather refined tools. He could take a block of wood or other required materials and work them patiently and with infinite care into the necessary shape or form—grace of line and accuracy of detail being the result of experience that had made him familiar with hull forms which would assure adequate speed and, withal, seaworthiness.

A delicate job of refitting for the modelmaker, who must have infinite patience, a facile touch, and a thorough understanding of all kinds of craft.

At a later date, when a knowledge of interpreting drawings had developed, the model became a simpler product because shipworkers no longer depended upon details in miniature to guide them in the execution of their tasks. A solid half model sufficed, and that model showed the outer aspects of the bare hull from stem to stern and from the keel up to the exposed decks.

From these half models, the men of the mold loft obtained the body lines, and, so helped, the woodworkers fashioned templates or patterns for the many different members constituting the ship's structural framework.

Eventually, these half models were commonly made from built-up blocks composed of successive layers of planking, of uniform thickness, held together by wooden pins or dowels—the meeting surfaces of two adjoining planks or "lifts" representing a waterline at a definite height above the keel. After the block was cut and chiseled into the form desired, then it was an easy matter to take the model apart—layer by layer—and transfer the contours of each waterline to paper. With this done, the ship carpenter, shipwright, or shipbuilder—whatever his designation — could then check off the dimensions at every point on the hull and make the full-sized part or parts accordingly.

With those half models as basic records, and with a fairly good approximate knowledge of how the intended craft would later perform when afloat, the designer of that period was able, from time to time, to effect improvements in his ships despite the fact that his procedure was largely a matter of "rule of thumb." Native cunning, a cultivated appreciation of "sweetness of line," a highly developed sense of feeling, and a keenness of eye combined to make the models a valuable aid in the building of ships.

As the science of naval architecture advanced, the designer was inclined to belittle the value of models. Because of his wider use of mathematics and the application of graphics to his work, he placed more and more reliance upon paper and pencil.

During the early stages of that period of the art many disappointing vessels were put overboard; and those failures were largely due to the fact that the men primarily responsible for the designs were not able to appreciate what the penciled lines would do when translated into the form of a floating body. It was inevitable that shipbuilders should come to realize that much might be gained by combining the information to be gathered from models as well as from drawings. This lesson was applied to advantage when iron, and later steel, was substituted for timber in the construction of water-borne craft.

As might be expected, models help to give the designer a ready grasp of the three-dimensional nature of his problem and are of outstanding aid to him in securing that balance of mass and features essential to strength, to appearance, and to correct functioning.

Most of us can draw a circle, and it isn't hard to imagine that circle to be the outline of a globe; but it is difficult to determine from that simple figure just how to proportion and to shape a single flexible piece of material so that it can be bent or pressed into the form of a sphere. If one have a ball upon which to fit a pattern, patience and persistence will make the solution of such a problem comparatively simple. The external plating of a vessel is the skin of the craft, and it must conform accurately to the changing lines and contours prescribed by the underlying steel ribs or frames; and this plating, in multiple units of many different shapes, must be ordered in advance of construction. Without half models on which to indicate the plating, it would be a wellnigh hopeless and very costly undertaking to prescribe the shapes and the sizes of the hundreds and hundreds of pieces needed in constructing a modern vessel of goodly tonnage.

The metal worker in this shipyard fashions things that would put to a test the skill of a watchmaker.

What we have said about the evolution of ship models explains how the highly specialized calling of the marine modelmaker developed accordingly; and today these men are doing things which would amaze their predecessors in the craft.

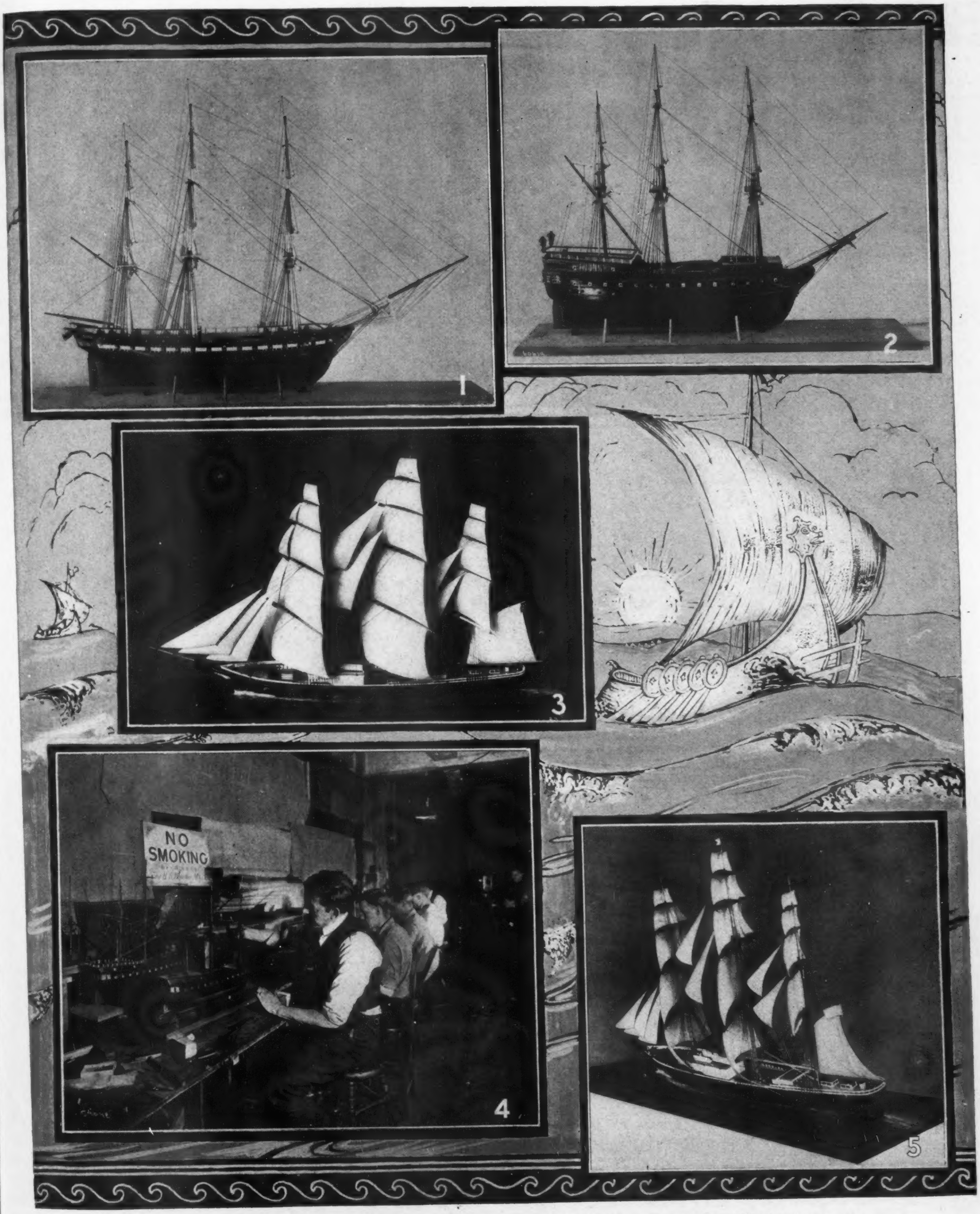
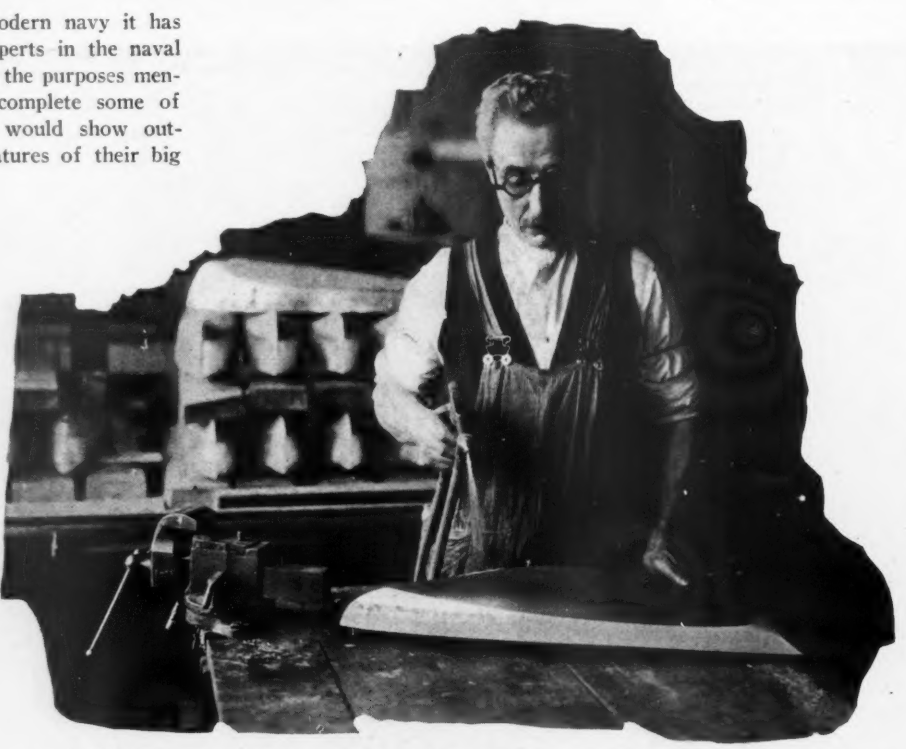


Fig. 1—Full-rigged model of the renowned United States frigate "Constitution."
Fig. 2—Model of the "Bon Homme Richard," made famous by John Paul Jones.
Fig. 3—Miniature replica of a noted American clipper ship under full sail.
Fig. 4—It takes patience and a love of the work to outfit models of ancient ships.
Fig. 5—Another view of the clipper-ship model taken from the port quarter.

Since the birth of our modern navy it has been the practice of our experts in the naval service to employ models for the purposes mentioned and, afterwards, to complete some of these models so that they would show outwardly all the structural features of their big relatives. The object was to preserve in this way a record of the growth of the battle fleet and to show how different types of war craft came into being. In short, to provide a continually expanding historical exhibit of our technical progress in the sea-going arm of our national defense.



Putting the finishing touches on the hull of a small sailing yacht with a paint spray.

Horace E. Boucher was for years associated with this work in the Government's service before he organized the business which now flourishes high above the busy streets of lower Manhattan. In fact, a considerable part of his work now is for the Navy Department. Steamship lines, other owners of vessels, shipyards, yacht builders, yacht owners, and certain of our educational institutions have followed the example set by the federal authorities—indicating the diversity of types which the Boucher Company builds. Incidentally, it explains why most of the men engaged in the work are master craftsmen and able to compete in the fineness of their handiwork with the products of the watchmaker. Some of our illustrations give a good idea of the different types of models built by the Boucher Company, and of the completeness and minutia of their make-up.

As might be expected, the need to save time and to lighten labor in this extremely interesting plant has led to the utilization of compressed air for numerous purposes. We can describe only a few of them. The dust that has accumulated upon old models, sent in for refitting or refurbishing, is removed quickly with jets of compressed air that can be so directed and controlled that they will do this work without deranging or damaging the most delicately constructed of these marine miniatures. Not only that, but compressed air is used to clear away dust, sawdust, and chips that may gather during the actual building of a model. Compressed air saves time in painting the different parts of these little vessels—because spray painting has virtually supplanted the brush and, as might be expected, the air-driven spray will coat surfaces and carry the paint where it is difficult if not nearly impossible to spread it with a brush. Compressed air has still other helpful services to perform in this skyscraper shipyard; and among these services are the testing of certain parts of the equipment of small self-propelled power boats of different types which have been developed by the Boucher Company. This brings us to the sport-loving disposition of the youthful American and, incidentally, his indulgent "dad." But before we touch upon this subject some figures might prove of interest.

The term miniature is a relative one, of course. The models of vessels vary in size agreeably to the sizes of the actual craft. That is to say, small yachts are reproduced on the scale of ¾ inch to 1 foot; large yachts are reproduced on a scale of ¼ inch to 1 foot; and ocean liners and battle craft are generally reproduced on scales ranging from ⅛ to ¼ inch to 1 foot. Plainly, the modelmaker must use a magnifying glass and tools that may be appropriately termed instruments to do some of his exacting work. This is especially true in the cases of certain features or fittings which are movable and which simulate as closely as possible their full-sized equivalents. Large models will cost up to $9,000 or $10,000; will require from four to five months for their completion; and will call for the services of from ten to twelve expert craftsmen.

Ship models do more than supply the element of the third dimension—they enable both the technical and the non-technical reader to visualize the relations of things and to get a proper sense of proportion. The habit is strong, and most of us do ask: "How does the thing work?" One of our photographs shows, in course of construction, the model of an ex-

Left—All ready to be lined up at the starting line. A flotilla of self-propelled speed boats.

Right—A schooner yacht in miniature jockeying at the starting line preparatory to a race.

press steamer for the Great Lakes so arranged that it will reveal the interior get-up and the equipment, motive power, freight, etc., which occupy the various compartments.

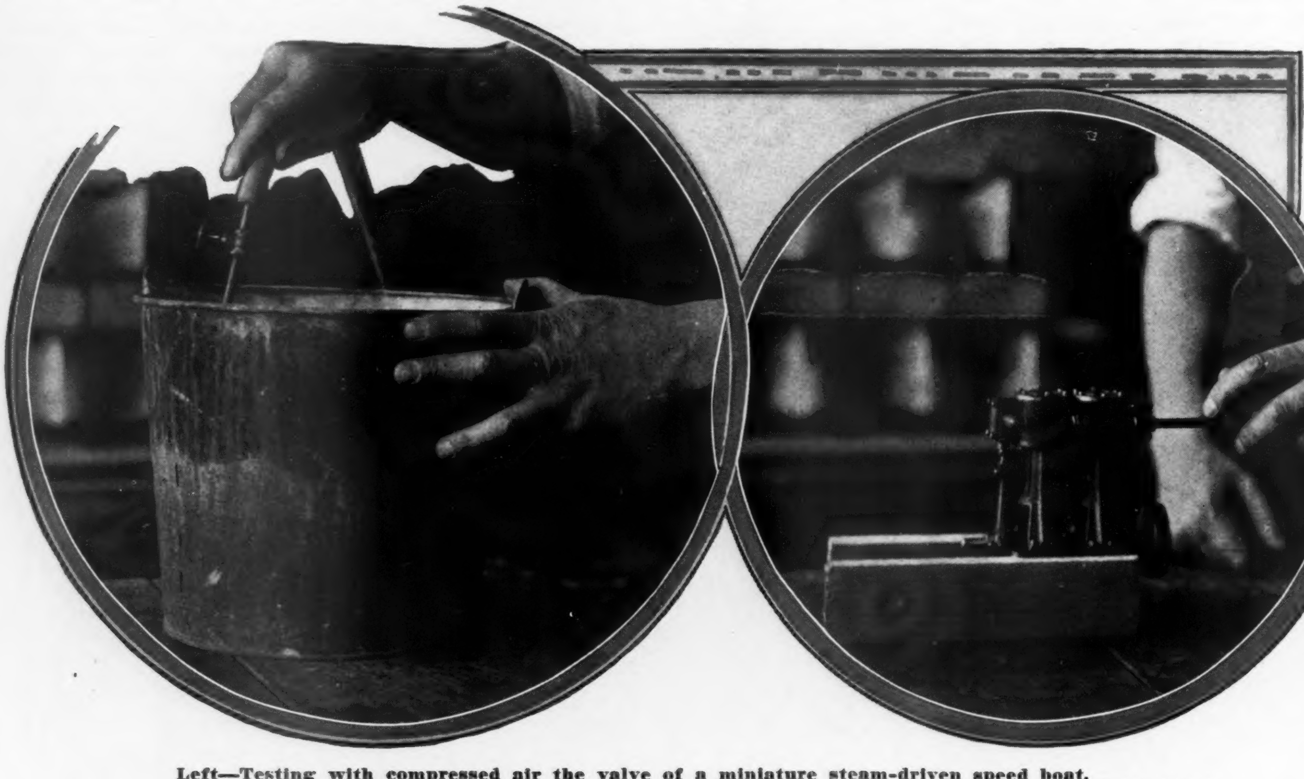
We cannot flatter ourselves that we have been pioneers in thus helping persons to familiarize themselves with the internal arrangements of full-sized craft. More than twenty years ago, our naval attaché at Berlin informed our Navy Department that all of the Kaiser's warships were furnished with skeleton models for the instruction of the personnel. The German Admiralty was alive to the need of everybody aboard a fighting ship being familiar with every phase of the vessel's construction and equipment. The Admiralty did this because it was aware that drawings and blueprints are not readily understood by the sailors and that even the officers sometimes find it hard to grasp their meaning.

Circle—Model of cup defender "Resolute" which beat the "Shamrock IV" in 1920.
Right—Making a model of a yacht before the prospective owner orders a full-sized craft.
Bottom—Building a detailed model of a Great Lakes passenger express steamer.

The naval attaché in question was subsequently stationed aboard one of our monitors in Asiatic waters, and it was brought home to him in a short while that he should know his ship in the fullest sense of the term. That is to say, he realized that he should be familiar with the positions of all watertight compartments; with the arrangement of the double bottom; with the manifold system of piping that safeguarded against disastrous leaks; with the proper ventilation of out-of-the-way subdivisions; with the distribution of motive steam; and with the arrangement of an extensive network of nerves in the form of electric wires and cables. For $110 in gold the officer got three Chinese carpenters to build him a beautiful and exact demountable skeleton model of the monitor. The ingenious Orientals used the simplest of materials to fashion the miniature ship—cunningly requisitioning macaroni to serve for piping and valves, and coloring each of these to indicate the particular service to which it belonged. It wasn't long before that officer and many of his shipmates had a far better understanding of the craft which they were serving than they might otherwise have acquired in the course of many months of association. In short, the information furnished by the model made them better able to deal promptly and correctly with any breakdown or service contingency.

Now let us consider for a few moments what might be called the pleasurable side of the Boucher Company's activities. This department of its work has to do with turning out sailing model yachts either complete as they stand or consisting of parts which can be assembled by any youngster able to handle a few tools. The latter unassembled yachts offer a lad a chance to test his constructive skill; and in either case the little boats enable him to master the fundamentals of watermanship and the handling of sailing craft. It is an inspiring sight to watch a contest among a flotilla of these boats; and the winning of a race is not merely a matter of chance but truly the result of the skill shown by the navigator.

As an outcome of this miniature yacht de-



Left—Testing with compressed air the valve of a miniature steam-driven speed boat.
Right—Compressed air supplies motive power in testing the engine for a miniature racing boat.

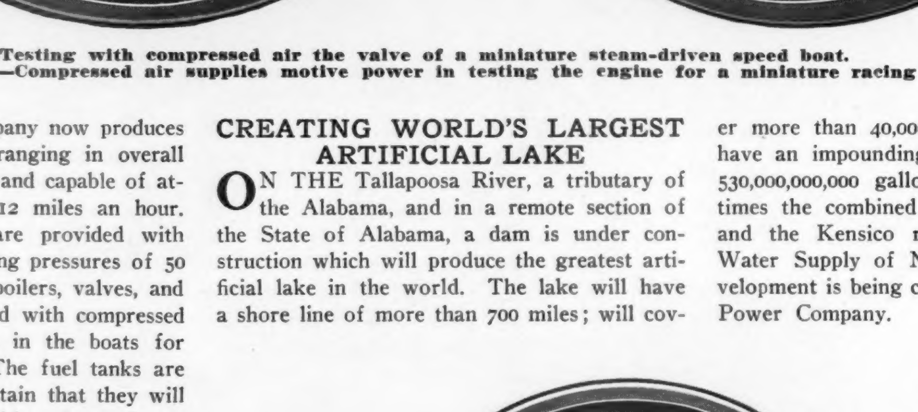
partment, the Boucher Company now produces steam-driven power boats ranging in overall length from 30 to 48 inches and capable of attaining speeds as high as 12 miles an hour. The little boilers, which are provided with superheaters, develop working pressures of 50 pounds and more; and the boilers, valves, and engines are thoroughly tested with compressed air before they are set up in the boats for which they are intended. The fuel tanks are similarly tested to make certain that they will carry their liquid charge with a large factor of safety. The miniature steam engines are complete in every essential detail; and the manner in which they work and the power developed by them are the best evidence of the skill and the mechanical cunning exercised in their fabrication. These power boats are more than a source of pleasure—they are the means of laying the foundation for a valuable understanding of marine engineering.

A fuel expert of the London Coke Committee has lately declared that England can maintain her industrial position only by extensively resorting to coal distillation. He believes that it will thus be possible for Great Britain to utilize her own coals to provide her with sufficient liquid fuels to take care of her domestic demands. This subject has been a matter of government research for a number of years.

CREATING WORLD'S LARGEST ARTIFICIAL LAKE

ON THE Tallapoosa River, a tributary of the Alabama, and in a remote section of the State of Alabama, a dam is under construction which will produce the greatest artificial lake in the world. The lake will have a shore line of more than 700 miles; will cover more than 40,000 acres of land, and will have an impounding area capable of holding 530,000,000,000 gallons, or more than three times the combined capacity of the Ashokan and the Kensico reservoirs of the Catskill Water Supply of New York City. The development is being carried out by the Alabama Power Company.

Cherokee Bluffs Lake, as it is to be named, is expected to be filled with water within two years and is to serve more than a single purpose. Three electric generators, each driven by a 45,000-H.P. turbine, will give light and power to a vast region; and the presence of this great body of water will make the surrounding country "frostproof," thus favoring the growing of fruit. Furthermore, the navigation of both the Tallapoosa and the Alabama rivers will be made more dependable the year round.



The high-pressure boilers of these speedy little racers are tested with compressed air before they are sent to the salesroom.

Aunt Ada's Axioms: Don't be tempted to let the milk of human kindness become ice cream. Warmth in friends is one of the few kinds of heat enjoyable in summer.

Care of Equipment Shows Up in Profits

By LION GARDINER

NO machine will perform at its best or repay its cost in work well done unless it is given a common-sense measure of care. It is gratifying to learn that this subject is now receiving so much attention.

We are indebted to our contemporary, Successful Methods, for the accompanying timely suggestions abstracted from an article printed recently in that publication. We believe that there is a lesson in the text which can be turned to profitable account.

THE operating organization of every construction job is divided into two parts, the human and the mechanical. Both are equally important if low production costs are to be obtained. The most expensive machine cannot turn out good work in the hands of incompetent operators who have neither pride in their work nor understanding of the parts they are to play. And even the best superintendent in the world cannot get good production and low costs unless his equipment is in first-class shape and has the care to which it is entitled. The various machines on the job which comprise the mechanical organization are entitled to the same care, thought, and study as the human organization, for without the former in good shape the latter cannot get continuous production.

The modern manufacturer and the contractor are really co-partners in the construction field. The reliable manufacturers of the country spend thousands of dollars in experiments and research work, testing new materials and working with new ideas with a view to turning over to the contractor for use in his work machines which will do their job efficiently and at the lowest possible cost. When a manufacturer has turned out a good tool, his reputation is in the hands of his contractor-customer. For if it is not maintained in good mechanical condition it will not do its work, and then its failure will reflect on the manufacturer's reputation. It is a fifty-fifty responsibility, resting equally on manufacturer and owner.

No one has ever been able to figure the money lost through the breakdown of equipment on busy construction jobs, but it is certain that a large percentage of this loss can be saved through better care of equipment. One way to insure better care is to pay more money in order to get a first-class man as operator. Perhaps a nickel or more on the hourly rate paid the operator, or the hiring of a good master mechanic whose sole job it is to inspect and keep the equipment in repair, will mean the difference between profit and loss at the end of the season.

Every contractor knows that some paving tools keep right on doing good work after 70 or 80 miles of road are finished, and others are ready for replacement at the end of the second season. The operator, and the man who is responsible for the upkeep, can make or break the best machine ever turned out.

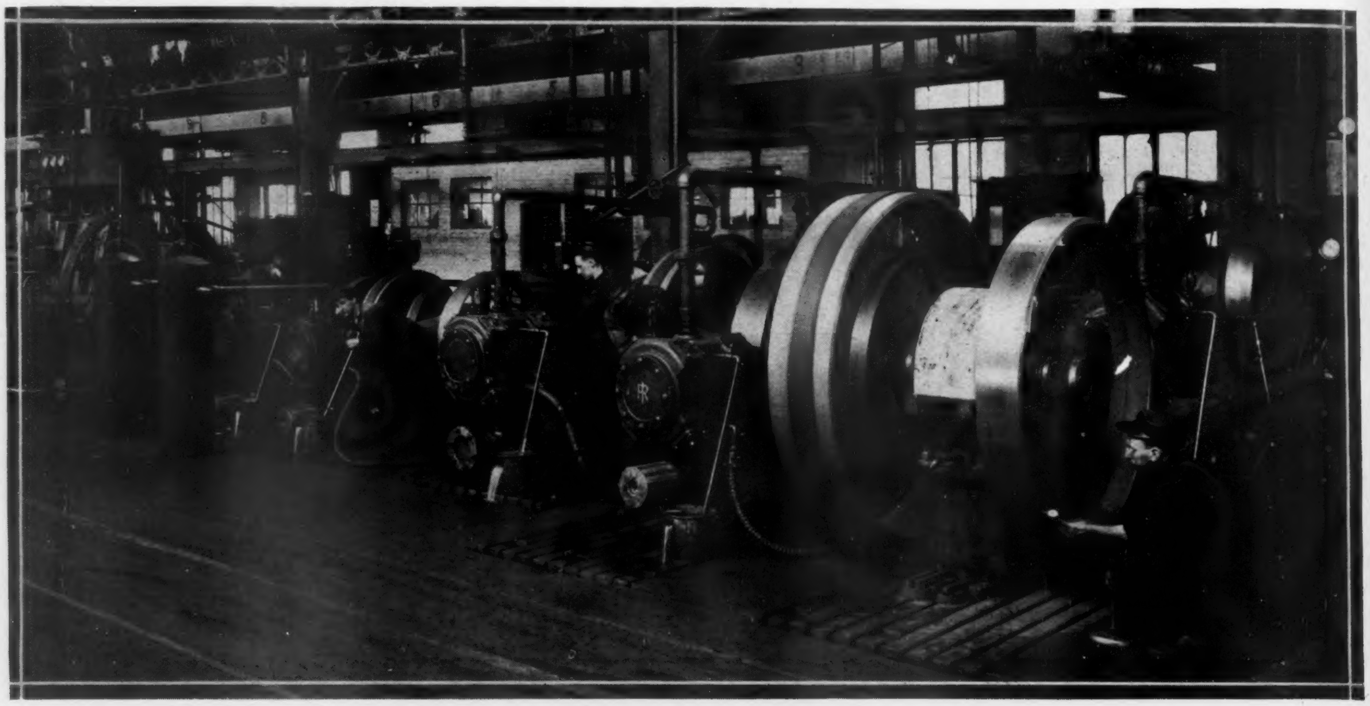
Upkeep does not merely mean some oil splashed around the machine a couple of times a day. It means careful oiling and greasing. It means thorough cleaning at night, tightening of the bolts here and there, and a willingness to make minor adjustments before they become major repairs. It also means, and this is important, the keeping on hand of certain spare parts which are most likely to go wrong, so as not to have to wait for factory shipment. A big paver standing idle because some part is on its way from the factory is one of the real tragedies of the roadbuilding game.

An Illinois contractor, who had a large job to complete within a specified time, determined to see to it that his equipment should be kept so fit that it would be able to perform efficiently day in and day out whenever the weather permitted. He knew that a few days of idleness on the part of some of his bigger units would spoil all chances for the record desired; and in order to keep his machines in first-class working order he offered cash prizes to such of his machinery operators that kept their machines clean, oiled and greased, free from breakdowns, and calling for the fewest, if any, repairs. To carry out this scheme, he appointed as judges of the contest the following executives: the superintendent, the mechanic, the construction engineer, and the timekeeper as well as himself.

To quote this wide-awake contractor: "The first two weeks our machinery looked as if it had been overhauled, and it was kept looking practically new the rest of the season. The bulletin announcing the contest was issued June 1, of last year. I will give you one illustration. We had an Erie steam crane that had not been cleaned and greased good for two years. After this bulletin came out, the operator and the fireman certainly made that crane look like new, and won the first

The application of a coat of white paint to the inside surfaces of a compressor crank case tends to make more conspicuous any accumulation of dirt or grime.

Nothing is more pleasing to the plant management than the pride shown by an engineer in seeing to it that his machinery is in first-class condition and running smoothly and efficiently.



Testing department of a large manufacturing plant where painstaking thoroughness insures the shipment of only mechanically perfect machines. Thoughtful care on the user's part will maintain these machines in good condition over a long period of usefulness.

prize. You can see that we had five different men on as judges, so that there could be no partiality shown. This has been the most effective method we have found to keep the machinery in shape. Cleaning and oiling is the life of machinery. We have found that when we are able to get the men to keep the machines cleaned and oiled the need for repairs is eliminated to practically the last degree. This contest caused the men to become very much interested, and the result was wonderful."

LOFTY AERIAL TRAMWAY IN THE ANDES

ON THE upper and eastern slope of the Andes, near the headwaters of the Amazon and at an altitude varying from 15,000 to 17,000 feet, is operated the highest aerial tramway in the world. With a total length of more than five miles, it leads down to a mill in the valley lying about 12,000 feet above sea level. This system of conveyance was adopted because of the prohibitive cost of roadbuilding.

The aerial conveyer is made up of two cables, suspended from steel towers—a stationary cable sustaining the weight and a moving and continuous one carrying the buckets. The tramway is in two sections which are both operated from a transfer station, where the sections meet. The buckets are placed at intervals of about 1,000 feet and move downward by their own weight and that of the load they carry. The empties are returned by the same continuous cable, getting their pull from the descending train of buckets.

AT a quarry in Vermont the compressed air used was formerly supplied by a steam-driven compressor, but more recently one with electric drive has been substituted, which has thrown the boiler out of a job. Under the earlier arrangement the cooling water for the air cylinder jacket was taken from the city mains and, of course, had to be paid for. The water now used is circulated through the old boiler—the horizontal heating tubes serving as efficient coolers for the water so that it is used over and over, and very little is required to maintain the supply.

This is a verification of the old saying that a stitch in time saves nine. Here a number of rock drills are being inspected and oiled in a mine repair shop.

WHAT might be called a new industry, and one with unlimited possibilities of extended employment, is the excavating of ditches by dynamite, and a new booklet issued by E. I. du Pont de Nemours & Company, Wilmington, Del., is filled with detailed and highly interesting information concerning the practice. In the past few years, 1,000 miles of ditches have been blasted by experts and an uncomputed length by farmers and drainage engineers. Costs of the work are included in the data given.

Aniakchak Crater, in Alaska, is said to be the nearest counterpart on earth to the craters of the Moon.

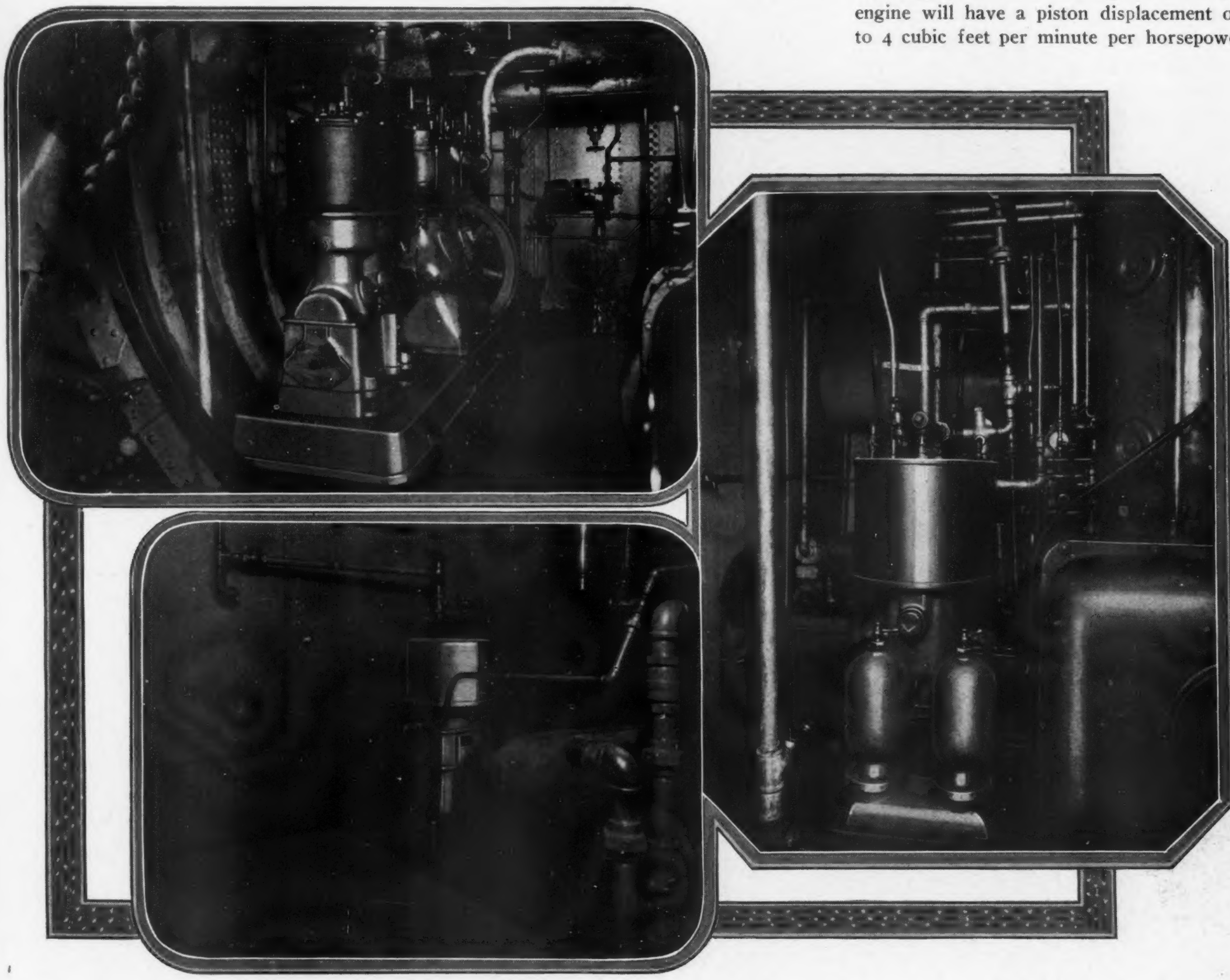
Uses of Compressed Air on Motorships

By L. V. ARMSTRONG

COMPRESSED air at pressures of from 60 to 1,000 pounds per square inch has many and divers uses aboard the motorship. A careful study of these applications brings one to the conclusion that in importance compressed air ranks second only to fuel oil; and in those ships where the so-called full Diesel type of engine is installed it is as necessary for the operation of the engine as the fuel oil. As the motor vessel is becoming increasingly popular by virtue of its low operating cost, a few words regarding the uses of compressed air and the methods of producing it on oil-engine-propelled craft may not be out of place.

As now manufactured, substantially all oil engines of more than 1,200 B.H.P. employ air at high pressure to inject the fuel charge into the working cylinder and to atomize it. This pressure varies somewhat with the make of engine and to a considerable extent with the load factor or percentage of rated horsepower which it is delivering. In any case, the pressure must be higher than the compression pressure of the engine to insure sufficient penetration for complete combustion. The injection air also serves to atomize the fuel charge, that is, to break it up into fine enough particles so that it burns readily upon coming in contact with the intensely heated compressed air in the cylinder. The work of atomization is performed in the spray valve. A quantity of fuel oil is delivered to this valve by a measuring pump. At the proper point in the cycle the spray valve is opened by a cam, and the injection air, which is always present at the valve, rushes into the cylinder—dragging the fuel charge with it through a series of intricate passages in the spray valve, which is designed to break up the fuel oil.

The amount of spray air required is, roughly, 10 per cent. of the displacement of the working cylinders of the engine. As a 4-cycle engine will have a piston displacement of 3.4 to 4 cubic feet per minute per horsepower of brake rating, it may be assumed that .35 to .4 of a cubic foot per minute, or 21 to 24 cubic feet per hour of injection air must be compressed for each brake horsepower developed.

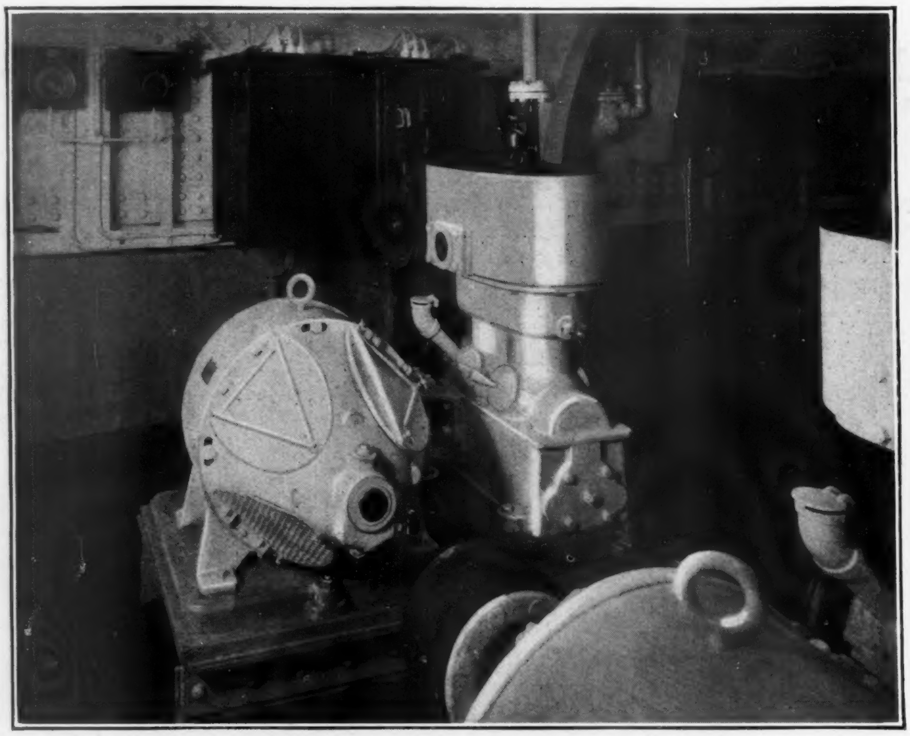


Top—Air for starting, for maneuvering, and for other services on the tugboat "Grace" can be provided by a stand-by compressor which is driven by an auxiliary oil engine.
Right—Aboard the tugboat "Grace," starting and maneuvering air is regularly furnished by an air compressor operated from the crankshaft.
Bottom—On the ferryboat "Hudson-Athens," starting and maneuvering air is supplied by a Type Fifteen, 2-stage compressor which is driven from the propeller shaft by a silent chain.

The horsepower required to produce this injection air is considerable. For purposes of ordinary discussion, it may be taken as 10 to 12 per cent. of the brake horsepower of the engine. In other words, for a 2,500-S.H.P.

engine, a compressor requiring 250 to 300 H.P. is an essential feature. In many designs the compressor is made oversize for reasons which will be given later.

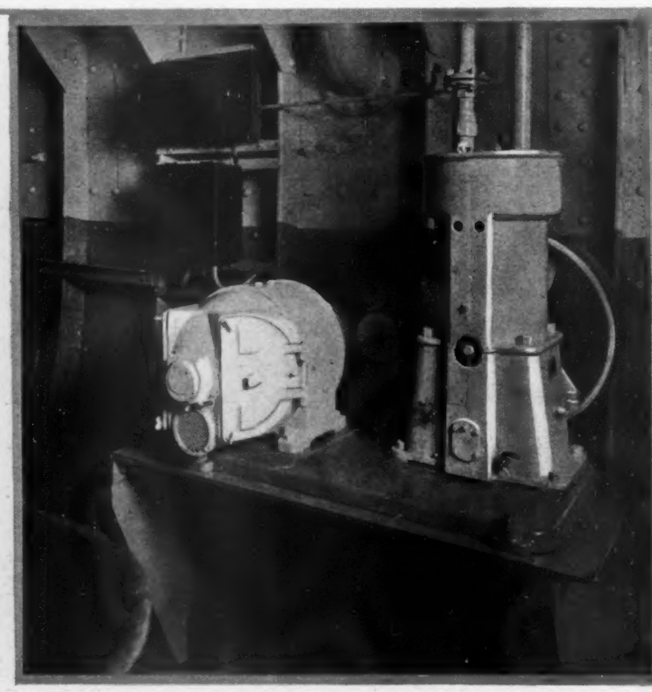
The injection compressor is usually driven from a separate crank on the engine crankshaft. For engines of large horsepower, to keep down the size of the cylinders, the compressor is built in tandem, each half having its own driving crank. This has a tendency to increase the overall length of the engine beyond practical limits. In the case of the conversion of certain Shipping Board vessels, now, being carried on, some manufacturers found it necessary to leave the compressors off the main engines and to drive them separately in order to get within the existing engine-room spaces.



Air for maneuvering the engines on the tanker "J. W. Van Dyke" is furnished by a small stationary vertical compressor short belted to a Westinghouse motor. The compressor is provided with an automatic pressure regulator.

With the demand for more horsepower on the shaft in larger and higher-speed vessels, the separately driven injection compressor will become more common. This type of construction has several advantages. From an installation standpoint, the engine is shortened; and at the same time, by increasing the mechanical efficiency, more horsepower is made available for ship propulsion. Operation is also rendered more efficient. A direct-connected compressor must be oversize for rated speed requirements in order to take care of the reduction in capacity at reduced revolutions per minute; and while operating at normal revolutions it is therefore necessary to reduce the output. In the case of a separately driven compressor, the air delivery can be efficiently controlled to meet the demand by employing a variable-speed motor or an automatic-clearance control. As probably 90 per cent. of the operation is at rated revolutions, the gain in efficiency is self-evident.

The air-injection Diesel engine has been subjected to much criticism as a result of the troubles encountered in the air compressor. These troubles have been largely due to the tendency of the engine manufacturer to regard the compressor as a side issue and to a failure to give the same study to it as is accorded to the shape of the combustion chamber, spray valve, etc. Compressing to 1,000 pounds in two stages, and air speeds beyond all practicable bounds are some of the features found in engines otherwise admirable in design. Regulation seems to be an unknown quantity: the method most commonly met with being to throttle the intake. With the development of a separately driven compressor it will be possible to purchase such a unit from manufacturers specializing in this type of machinery; and the troubles may be expected to decrease to a point compatible with a ma-



Left—On each of the "Van Dyke" tugs a 6-H. P. Bulldog engine drives a 4-Kw. generator as well as a 4½ by 5-inch compressor.
Right—An additional supply of operating air is assured on each of the "Van Dyke" tugs by a 4½ by 5-inch I-R compressor driven by means of a short belt by a General Electric motor.

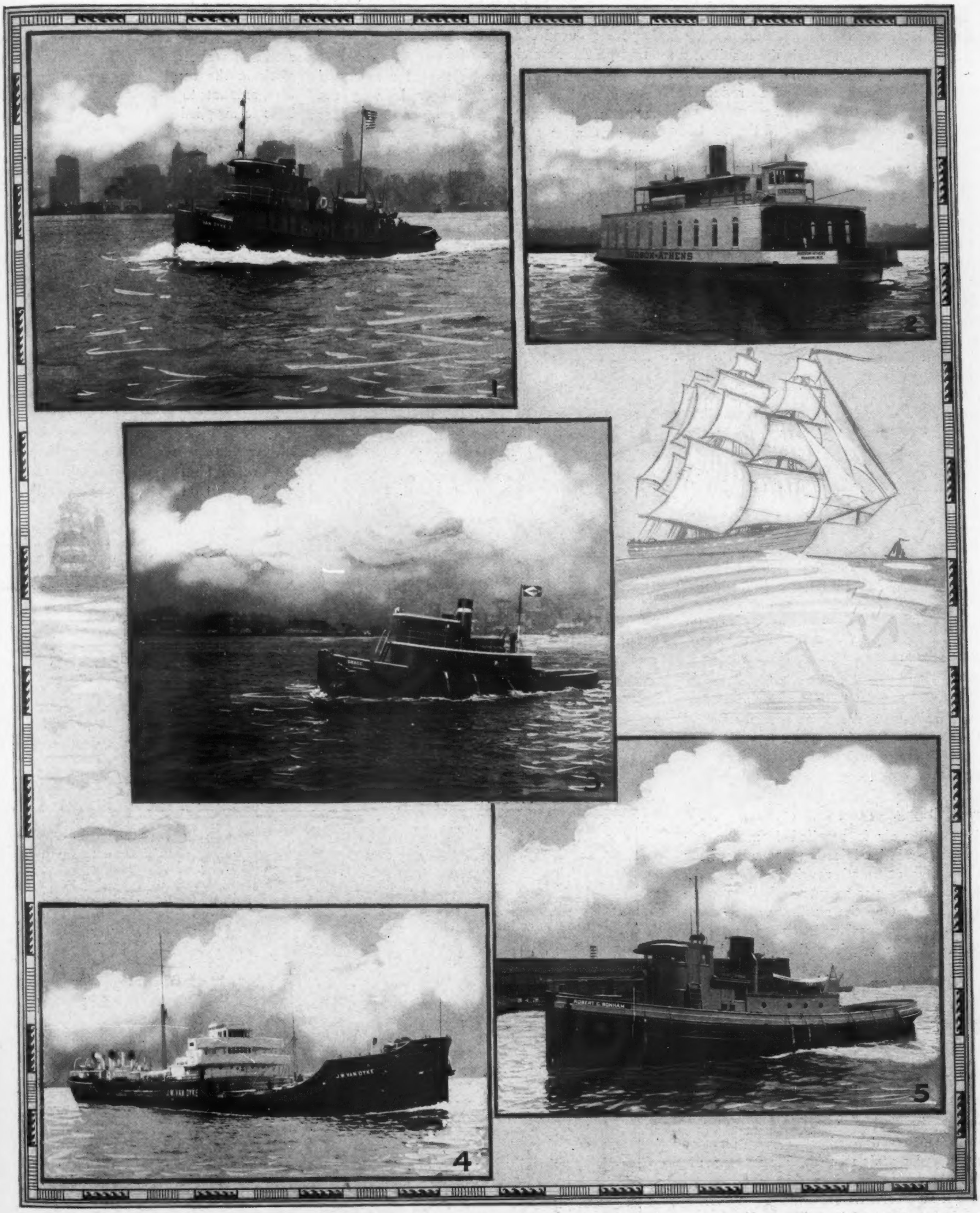


Fig. 1—"Van Dyke 3," one of three sister tugs having oil-electric drive. Each of these boats is driven by two 225-H.P. engines.
Fig. 2—Ferryboat "Hudson-Athens," propelled by a direct-reversing 220-H.P. oil engine.
Fig. 3—Motor tug "Grace" fitted with a 320-H.P. direct-reversing oil engine.
Fig. 4—Tanker "J. W. Van Dyke," equipped with oil-electric drive—the prime movers being three 840-H.P. marine oil engines.
Fig. 5—Tug "Robert C. Bonham," driven by a 400-H.P. direct-reversing oil engine.
The solid-injection Ingersoll-Rand oil engines installed on all the foregoing vessels are provided with separate compressors to furnish air for starting and maneuvering.

chine requiring as small clearances and having as delicate a lubricating problem as a 1,000-pound compressor.

The solid-injection engine is the result of an effort to get away from the troubles mentioned in the foregoing paragraph and to reduce the engine length. In this type the fuel charge is injected by pump pressure, and the need for 1,000-pound air is eliminated. Up to the present only one or two successful systems for accomplishing this have been produced, and as these are covered by basic patents their widespread manufacture cannot be expected for some time.

Both air-injection and solid-injection oil engines require compressed air for starting; and in the case of direct-reversing engines it is likewise needed for reversing. The pressure needed varies with the compression pressure of the particular type of engine. For 500 pounds compression a maneuvering pressure of 350 pounds is ordinarily used, and for 350 pounds compression one of 200 pounds. This starting air is admitted during what is normally the firing stroke, when both the intake and the exhaust valves are closed. The admission lasts for about two-thirds of the stroke.

General information as to the amount of air required for a start is not available. It varies with the mechanical efficiency of the type, the physical condition as regards repair and adjustment of the particular engine, the quality of the fuel, the engine-room temperature, the skill of the operator, and many other factors. Under favorable conditions the amount is extremely small, but as the unfavorable condition is the one which must be taken into consideration the make-up and storage capacity should be several times that normally required. The inspection bureaus such as Lloyd's, American Bureau, etc., specify the minimum number of starts the storage capacity should permit without replenishing.

This starting air is supplied from the excess capacity of the injection air compressor when running at rated revolutions. At reduced revolutions per minute it is frequently necessary to start up the auxiliary compressor when much maneuvering is going on. The American Bureau requires that there be at least one such auxiliary compressor capable of satisfying the requirements of the main propulsion engines when operating at 50 per cent. power output.

Two-cycle engines use low-pressure air of from 1.5 to 5 pounds per square inch for scavenging the cylinder of exhaust gases. Good design places the amount of this air at about 1.5 times the cylinder volume. Various schemes have been devised to provide this air. The most successful are: the scavenging or low-pressure air pump, driven by a beam or an engine crank, for small and moderate horsepowers, and a motor-driven blower for very large engines. Crank-case compression is one of the several attempts to reduce cost. Any attempt to provide this air by using the underside of the working piston as a compressor must be imperfect, as the volume of air so produced as a result of volumetric efficiency must be less than the cylinder volume of the engine. The result is incomplete scavenging and a reduced charge of air for the combustion of the new charge of fuel.

The next most common use of compressed air aboard a motorship is for blowing the whistle. It should be remembered that where all auxiliaries are electrically operated there is no steam available for this purpose. There are a number of air-actuated whistles manufactured which, from a sound-producing standpoint, are at least as efficient as steam.

Compressed air is also used to operate water pumps, steering gears, hoists, and pneumatic tools, and to transfer fuel from one tank to another. Where air is used to run engine-room and deck machinery of the steam type the results are wasteful, as such machines have no cut-off—taking air or steam, as the case may be for their full stroke without expansion. Where machines designed to operate economically by air can be used, good results are possible up to a maximum of 5 H.P. for continuous duty; but for intermittent service, machines of considerably higher horsepower can be operated by air to advantage.

A test track for automobiles has been built by manufacturers of Berlin, Germany, extending from that city to Wannsee, a suburb. Known by the name of "Avus," the road consists of two parallel tracks terminating in circles at each end. It is for various practical uses rather than for sport. One manufacturer made a continuous 240-hour test run with his machine to prove its wearing quality, among other things. Drivers were changed every four hours from another machine running alongside—in other words, "on the fly."

STEAM IN THE PAPER MILL

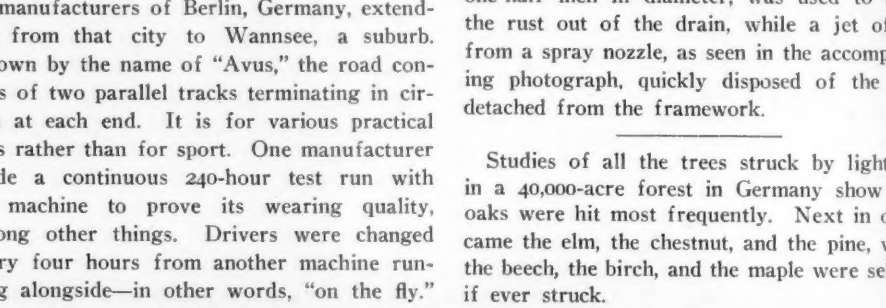
IN the latest Canadian paper mill the consumption of steam, chiefly for heating the rolls and evaporating the water from the paper stock in the continuous process of manufacture, amounts to about 200,000 pounds per hour. This is supplied by two 25,000-kilowatt steam generators supplemented by four fuel-heated boilers. Many pulp and paper mills in Canada are adopting the electric-steam generator on account of the inexhaustible supply of water power and the comparatively low cost.

DO IT WITH AIR

"MAKE compressed air do your work wherever possible," is the slogan of the engineer of the Mechanics Building, San Francisco, Calif. He was recently called upon to remove an accumulation of rust from the framework of a sidewalk elevator and from within an underground drain pipe leading from the elevator to the gutter.

After first loosening the rust as best he could with chisel and hammer, he tapped the elevator air supply for the purpose of completing the work. In other words, a stream of compressed air, fed through a piece of piping one-half inch in diameter, was used to blow the rust out of the drain, while a jet of air from a spray nozzle, as seen in the accompanying photograph, quickly disposed of the rust detached from the framework.

Studies of all the trees struck by lightning in a 40,000-acre forest in Germany show that oaks were hit most frequently. Next in order came the elm, the chestnut, and the pine, while the beech, the birch, and the maple were seldom if ever struck.



An air jet made quick work of blowing away the rust previously detached by chisel and hammer.

Compressed Air Saves Time and Money in Public-Service Shop

By THE STAFF

PROPERTY owners, lessees, and tenants in a populous city little realize what has to be done by a public-utility corporation to provide and to maintain a continuous supply of electric current for lighting and for many other purposes.

An important factor in the solution of this problem is the distribution department, and upon this department rests the responsibility, first, of making the needful connections between the buildings and the cables buried beneath the surface of the contiguous streets and, next, seeing to it that these connections and the cables as well are kept in perfect working order.

To do these things properly and promptly—for the public is always impatient and exacting—requires a trained personnel and an array of tools and other equipment capable of meeting the varied requirements of a many-sided service. To keep the cost of this service low enough to satisfy the subscriber and to insure at the same time a reasonable profit to the utility company it is necessary that the company save money wherever that is possible. We are going to tell how this is achieved in the case of one great electric corporation through the use of compressed air and pneumatic equipment of different kinds.

Air for different services in the shop is provided by a 9x8-inch compressor belt driven by an electric motor. The air receiver is large and has a height of 10 feet and a diameter of 42 inches.

About three years ago, the shop of the distribution department of the Brooklyn Edison Company, Brooklyn, N. Y., faced a rapid increase in its work. The solution lay in either enlarging the shop so that the work could be done by a bigger force or in installing facilities which would enable the existing force to handle the many and diversified jobs that required attention from day to day. Most of the work consisted of making tools or sharpening tools used by outside gangs in digging up streets, refilling trenches carrying electric conduits and cables, or in making the connections between the cables and the wiring systems within flanking houses or other buildings. In short, the tasks were essentially those of a busy blacksmith shop.

Prior to the spring of 1922 all this blacksmith work was done by hand, and the force employed was made up of two blacksmiths and two helpers. Despite their best efforts they found it hard at times to keep up with the demands made upon them by the outside gangs. Then it was that the Brooklyn Edison Company decided to equip the shop with a compressor plant and other facilities operated by compressed air. To be specific, the shop, without any enlargement, was provided with a 9x8-inch belt-driven Ingersoll-Rand compressor and a 10x 3½-foot receiver capable of holding enough air at 100 pounds pressure to meet the ordinary requirements of the shop. In addition to the compressor and receiver there were set up a No. 50 "Leyner" sharpener, a No. 25 oil furnace, and an electric-driven grinder. This equipment made a tremendous difference in the capacity of the shop to meet all demands, and enabled a force consisting of one blacksmith and a helper to do a volume of work which would have overtaxed the previous force of two blacksmiths and two helpers, who did all their work by hand.

Steels are made ready for many uses by a No. 50 "Leyner" sharpener. The shop is also equipped with a pedestal grinder.

The "Leyner" sharpener is a very adaptable machine: with proper dies it can be used to shape and to sharpen many kinds of steel implements or tools. It does its work quickly and well—the results being of uniform excellence when operated by a competent blacksmith; and the best service can be got out of the machine when the steels or tools to be formed or sharpened are heated in an oil furnace of the type mentioned. The grinder is used for certain grinding or sharpening jobs that require the action of a wheel and which cannot be done as well or as conveniently on a sharpening machine of any other sort.

The blacksmith shop of the Brooklyn Edison Company is called upon to shape or to sharpen tunneling bars, crowbars, picks, asphalt cutters, bull points, paving-breaker steels, star drills, over-

head digging bars, and points for grounding pipes. By the old method, a piece of iron bar was welded in a ½-inch pipe and then pointed by hand. It was possible for two men to do 60 during an 8-hour day. Now they can be made ten times as fast. Grounding pipes are from 18 to 20 feet long and are driven into the ground outside a building whenever people object to the electric circuit being grounded on the house water or sewer piping.

The following figures will give some idea of the quantity and the diversified character of the work done by this up-to-date blacksmith shop. Each day there are sharpened in the shop 60 bull points and 30 asphalt cutters; and in the course of a week are sharpened 50 crowbars, 100 tunneling bars, 300 star drills, and from 300 to 400 picks. In short, the shop has to take care of the tool needs of the outside gangs working continuously with something like 15 portable compressors. These compressors supply the necessary air for the tools which break through street paving, dig trenches, ram back the earth in refilling, drive the pipe from the streets to the houses, and drill holes through foundations to complete the connections between the light or power cables and the wiring systems within buildings.

In all this work speed is essential so that the streets shall not be blocked except for the shortest possible time, and speed is also required so that the subscriber's service be installed quickly and maintained thereafter without interruption as far as it is possible to do so. Manifestly, sharp tools and enough of them must be continually available; and it is also of prime importance that the cost of these tools should be kept as low as practicable consistent with fitness for their different tasks. Compressed air and air-driven machines or appliances make these desired ends attainable.

All steels for different purposes are heated in this "Leyner" oil furnace.

The southeastern portion of Alaska, immediately most interesting and important, is to be mapped by airplane photography by officers of the Department of the Interior in coöperation with the United States Navy. Seaplanes are expected to be used on account of the lack of proper landing places on the mainland. The proposed maps are primarily sought in connection with the investigation of mineral resources by the Geological Survey; but the other bureaus, the Coast and Geodetic Survey, the Forest Service, the General Land Office, and the Federal Power Commission will all be benefited and will assist in the work as much as possible.

HOW AIR CAN BE SAVED IN SAND BLASTING

WHEN compressed air is used for rock drilling or for operating pneumatic tools it is comparatively easy to measure and to compare the efficiencies so as to detect extravagant wastage, but in the case of the sand blast the work done cannot be measured or compared with any approach to precision. As a consequence, much wastage goes undetected. The United States Silica Company has called attention to this matter in a recent advertisement, in which are also given some interesting facts as to actual waste and actual savings effected.

In the course of a series of investigations it was found that under circumstances the cost of the compressed air may be greater than the wages paid the sand blasters; greater than the total cost of the abrasives used; greater than the maintenance, amortization, and up-keep cost of all the equipment. Some of the general causes for wastage are easily apparent, namely: pressure is too high; nozzles are too large; hose is old and leaky; and the compressor is in bad order.

In a particular case, the expert put pressure reducers on the air line, cutting the pressure from 90 to 70 pounds, and replaced the ½-inch nozzles with ⅜-inch nozzles. In this simple fashion the most serious air leaks were remedied. It was found that a ½-inch nozzle and air at 90 pounds pressure permit a flow of 376 cubic feet of free air per minute, requiring 72.19 H.P. The substitution of ⅜-inch nozzles and air at 70 pounds pressure cut these figures to 171 cubic feet of air, and 28.73 H.P., respectively, a saving of more than 60 per cent., or 43.46 H.P. for each nozzle. At the same time the sand-blast output was slightly increased, because the free-flowing properties of the hard, non-splitting abrasives put the air to more efficient use.

TRAVEL BY AIR IS ON THE INCREASE IN GERMANY

TO travel by rail nowadays instead of by air is to be behind the times in Europe, at least, and is not to be considered when speed is an essential in the conduct of business. The demand for aerial transportation has increased so greatly that two German air lines have had to enlarge their services—last year's 98 per cent. safety record doubtless being a big factor in the steadily increasing number of passengers. The new air-transport plan provides for 25 lines making daily flights.

The center is Berlin, where about 30 machines start and land every day. Connections with other international lines are made in Munich, Königsberg, and other large cities. A few comparisons show the great savings in time effected. From Berlin to London is 9 hours by air and 21 by express train. From Berlin to Geneva the flight takes about 9 hours instead of two days of roundabout travel by rail. To go from Berlin to Moscow or Helsingfors, the air traveler flies first to Königsberg in 4 hours and then, on the next day, proceeds to Moscow in 10½ hours or to Helsingfors in 8½, while the speediest trips by train and ship are of several days' duration. In the matter of price, the air lines compare most favorably with railway service; and there is, besides, a saving in incidental expense on the way.

In the Sunset Field, near Maricopa, Calif., Well No. 6 of the Atlas Oil Company had a steady flow of 400 barrels before the recent great earthquake. Immediately preceding the disturbance the pressure increased, causing an oil flow of 2,000 barrels a day with a gas flow of 2,000,000 cubic feet. This continued for eight days. The well then sanded up; and since being cleaned out it produces daily 1,000,000 cubic feet of gas and 700 barrels of oil.

At Blackpool Tower, an English seaside resort, a record was made recently in cutting some heavy cast-iron flywheels with an acetylene blowpipe. The first cut—a section of 10½x22 inches, or 231 square inches—was made in 40 minutes at an expenditure of 540 cubic feet of oxygen and 80 cubic feet of acetylene.

Rapid Progress on Broad Street Subway in Philadelphia

This Big Four-Track Subway is Part of an Extensive Program of Rapid-Transit Development

PART I

By ROBERT G. SKERRETT

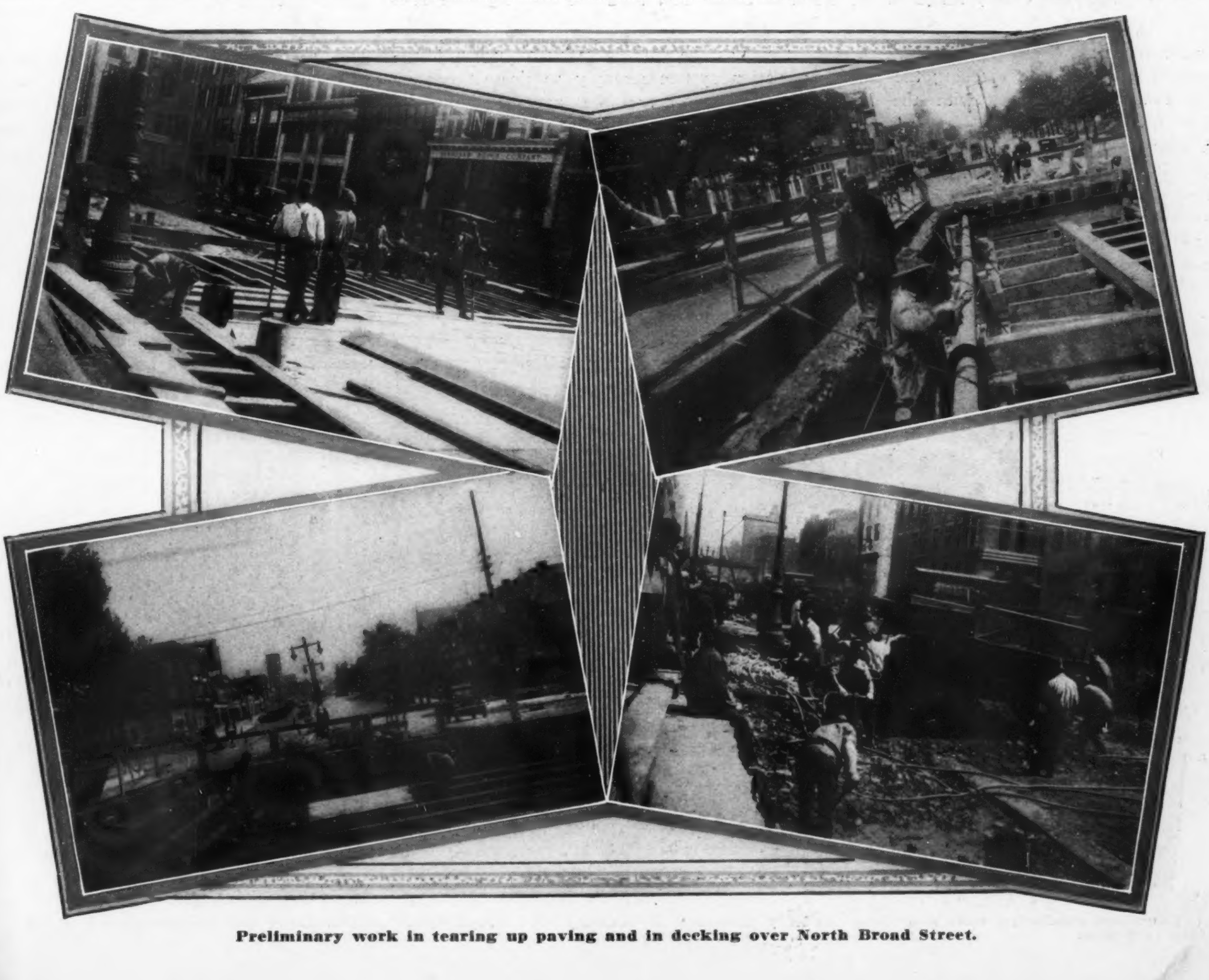
SUBWAYS, as a means of rapid transit, ceased to be a novelty some years ago. But subway building still grips the imagination and tests the resourcefulness of the engineer.

Therefore, the engineer must employ any machines, tools, or other facilities that will enable him to forge ahead faster and faster. The digging of the Broad Street Subway is of more than ordinary interest owing to the mechanical aids used, which make it possible to establish new progress records.

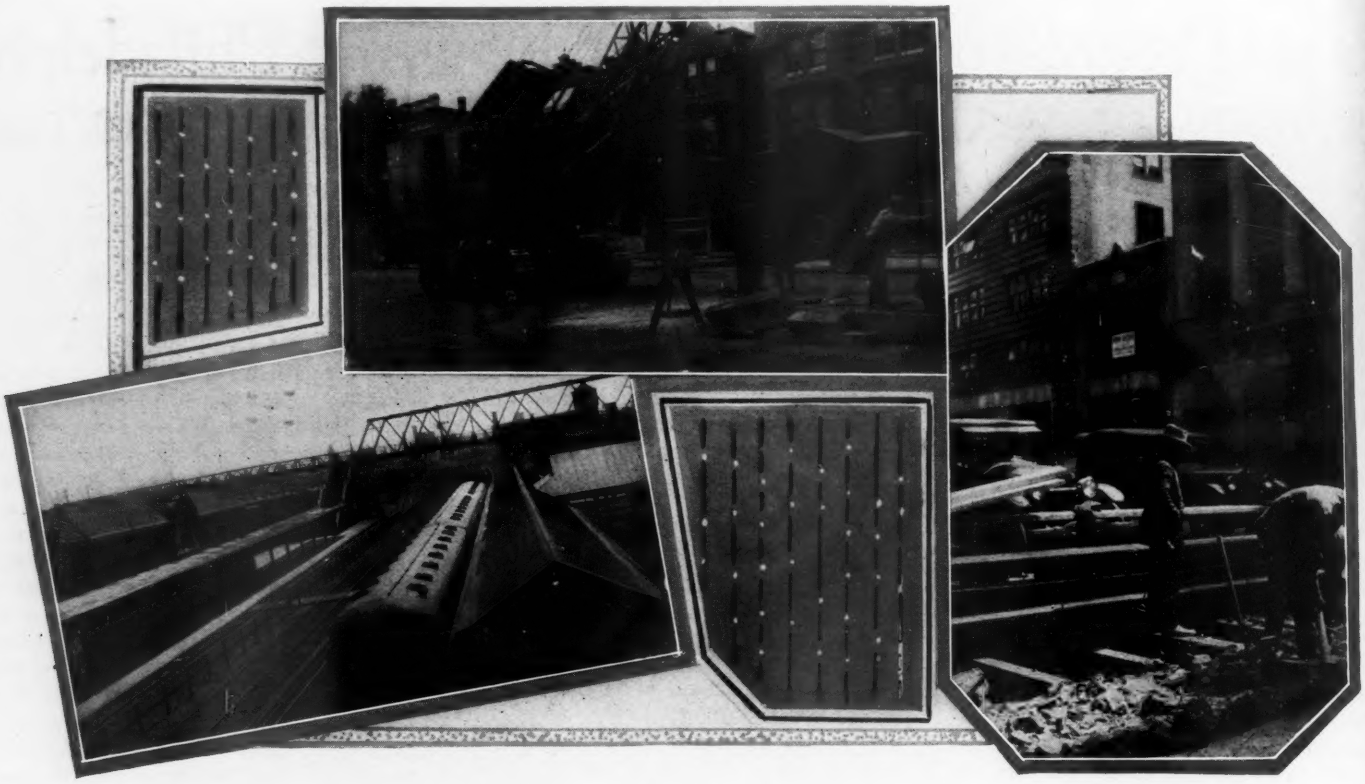
PHILADELPHIA has in hand the construction of a rapid-transit subway system which, when carried to completion, will involve the expenditure of many millions of dollars. When finished, this comprehensive scheme will give Philadelphia transportation facilities which she has needed for some time.

It would not be out of place at this point to mention some of the circumstances and the changes in the life of Philadelphia which have forced the city fathers to agree upon the rapid-transit program which we shall outline in a general way presently. The physical limits of Philadelphia embrace a very large area, and this has been the case for decades. Nevertheless, the expansion of the inhabited sections has been especially pronounced during the last 25 years, and this expansion is directly traceable to the city's increase in population and to the traditional effort to maintain Philadelphia's enviable reputation as a city of home owners or home dwellers.

In 1900, Philadelphia had a population of 1,293,697. According to the most recent estimate, the population is now placed at 1,979,364; and it is apparent that the number of residents within its gates will soon reach a total of 2,000,000. As a matter of fact, Philadelphia is today the third largest of our municipalities; and it has long been the boast of Philadelphians that a greater percentage of them live under their own roofs than has been the case in any other sizable city in the United States. Accepting this as true, it is self-evident that any substantial increase in population would entail a nearly corresponding expansion of the built-up sections of the community and, therefore, compel an augmenting number of the populace to establish homes farther and farther from the civic center—thus bringing about a greater daily



Preliminary work in tearing up paving and in decking over North Broad Street.



Top—Caterpillar-tractor derrick. One of several that have helped greatly to facilitate the handling of materials.
Left—One of the depressed railroad crossings beneath which the Broad Street Subway has to pass.
Right—An early stage of the work in connection with the decking over of the much-traveled thoroughfare.

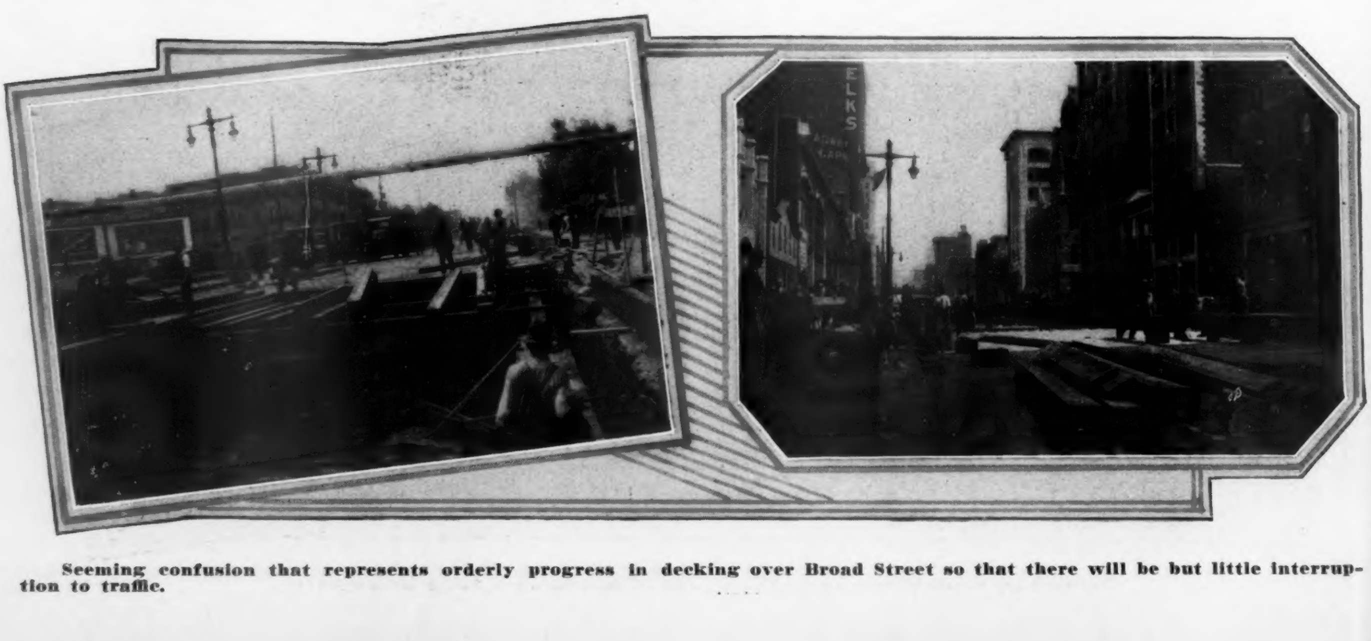
movement of people bound to and from their occupations or bent upon reaching the shopping and business districts with the least delay.

Mr. Henry E. Ehlers, Director of Transit for the City of Philadelphia, has explained the situation in the following lucid manner: "The growth of a modern city brings in its train certain transportation needs which gain in importance as they affect the welfare of the community and the comfort and the convenience of the citizenry. It is not an overstatement to say that this matter of ample transportation facilities concerns every individual and every local interest.

"Just as the passengers on an urban transportation system multiply so does it become necessary to carry the average individual farther. And experience has proved that this augmented volume of traffic cannot be moved to and fro between the residential and the business sections of a city by facilities using street surfaces. In other words, subway or elevated lines must be provided to handle at high speed what might be termed the great mass of passengers, while a smaller percentage could be taken care of by feeder bus lines and by coördinating lines of surface cars. In no other way is it practicable under present conditions to improve the means of transportation and, at the same time, relieve the congested traffic on busy streets.

"Conversely, the growth and the expansion of a city is directly influenced by the time saved, by the gain in convenience, and by the rates of fare charged on any high-speed system which makes it possible for the population to spread away from the center of the city in an effort to obtain comfortable housing conditions combined with adequate and reasonably priced transportation."

Nine years ago, the responsible civic authorities agreed upon a decidedly comprehensive system of rapid-transit lines, commonly known as the Taylor Plan, and they then authorized



Seeming confusion that represents orderly progress in decking over Broad Street so that there will be but little interruption to traffic.

Left—A loaded truck backing up a ramp in removing excavated earth. Right—Water mains that have been displaced in digging the subway trench.

certain loans to carry out the several associate projects. Even so, actual execution was limited to work on the City Hall Station of the Broad Street Subway, on the Frankford Elevated Line, and on some sections of the Arch-Locust Streets Delivery Loop. Our participation in the World War arrested further progress, and it was not until near the end of 1922 that the elevated line to Frankford and the surface line to Bustleton were finished and placed in service.

By that time, it became apparent to the students of the situation that the Taylor Plan would have to be modified; and in July of 1923 the needful modifications were determined upon and endorsed in September by a referendum vote. Early in the following November, the voters authorized the borrowing of the money required to carry out the approved program. The comprehensive character of the scheme can be made clear by a brief description of it.

The program called for the immediate constructing of a 4-track subway in Broad Street extending northward from Spruce Street—2,000 feet south of City Hall—to Olney Avenue, north of City Hall, and thence by a short run to a terminal yard a little to the north and east of that intersecting thoroughfare. The entire run will ultimately cover a distance just a trifle less than seven miles. The plan also contemplated the simultaneous building of a 2-track branch under Ridge Avenue from Broad Street southeast to 8th Street, thence southward to Walnut Street, and from that point westward under Walnut Street to the Schuylkill River where the line would cross that stream by bridge. From the bridge, the route would run westward to 42nd Street in West Philadelphia and there connect with an elevated railway on Woodland Avenue—the latter line extending to Darby. In addition to this, the program included a subway in Chestnut Street for surface cars—the subway to extend from the Schuylkill River on the west to the Delaware River on the east where it will connect with the plaza at the western end of the great Delaware River Bridge. At the Schuylkill River end of this surface-car subway the line will be carried across that river on a bridge and will be linked with existing surface lines that traverse West Philadelphia.

Early in 1924, appropriation ordinances were passed which made available more than $57,000,000 towards the building of the Broad Street Subway and $10,000,000

Various activities along the line of the Broad Street Subway.

Placing steel girders over the shallow trenched street preparatory to laying the deck. Subsequently, the excavation is carried to the full depth—the girders being suitably supported at several points.

One of the several shafts, in the middle of the street, employed by one of the contractors to raise excavated material to the ground level. When brought to the surface, the earth and rock are then dumped into large motor trucks and carried away.

Ramps are employed by one of the contractors in bringing excavated materials to the surface. The ramps are built with a gradient which can be used by both loaded and unloaded motor trucks.

towards the constructing of the Chestnut Street Subway for surface cars. The Department of City Transit was then directed to proceed with the drafting of plans for the Broad Street Subway and its connecting branches—officially known as Step No. 1, and authority was given to start work on this part of the project.

Work on Step No. 1 was begun when ground was broken in Broad Street about August 15, 1924. Up to date, activities on this great undertaking have been concentrated upon three sections in North Broad Street lying between Filbert Street and Courtland Street and representing a combined length of 26,000 feet. Fine progress has been made by the two big contracting companies concerned, that is, the Keystone State Construction Company of Philadelphia, Pa., and Patrick McGovern, Inc., of New York City. How each of these contractors has handled his problem and how compressed air has aided to a marked degree the rapid prosecution of the work will be described in succeeding issues of the Magazine. For the present we shall confine ourselves to some of the physical circumstances that have had to be taken into account and to certain conditions which have stressed the urgent need for this traffic artery.

The City Hall is at the civic center of Philadelphia and stands at the intersection of Market and Broad Streets. Both of these thoroughfares are filled with vehicular traffic at certain hours every weekday, and North Broad Street is a feeder to an enormous section of the city proper and to outlying suburban districts. Accordingly, it has been essential that the contractors engaged in building the Broad Street Subway should carry on their work in a way that would least interfere with the normal traffic tide. Furthermore, it is equally important that operations underground should be advanced with all practicable dispatch and with the least possible interference with the safety, the comfort, and the convenience of the residential and the business sections on or contigious to Broad Street. The steps taken to this end have in some respects been novel and indicate engineering developments of an interesting character.

Preliminary examinations along the route disclosed in a general way the geological formations that would be encountered in digging the different sections of the subway. Starting at the City Hall, the ground has ranged from clay with a 10 per cent. admixture of soft mica schist to a prevalence of 80 per cent. of hard mica schist throughout the northernmost section of the project. Manifestly, different facilities have been required to deal speedily and effectually with the different grounds.

The fairway between curbs on Broad Street is 69 feet wide, and the 4-track subway between the two inner flanking faces has a total width of 53 feet. Therefore, the contractors have been obliged to excavate beneath the sidewalks and, in places, to the building lines in order to relocate water mains, gas mains, telephone lines, and high-power electric cables. This work has called and will continue to call for skilful and very careful handling. In addition to this, the contractors have been obliged to re-

City Hall and nearby streets where traffic is dense during a number of hours daily. The Broad Street Subway will do much towards relieving this congestion.

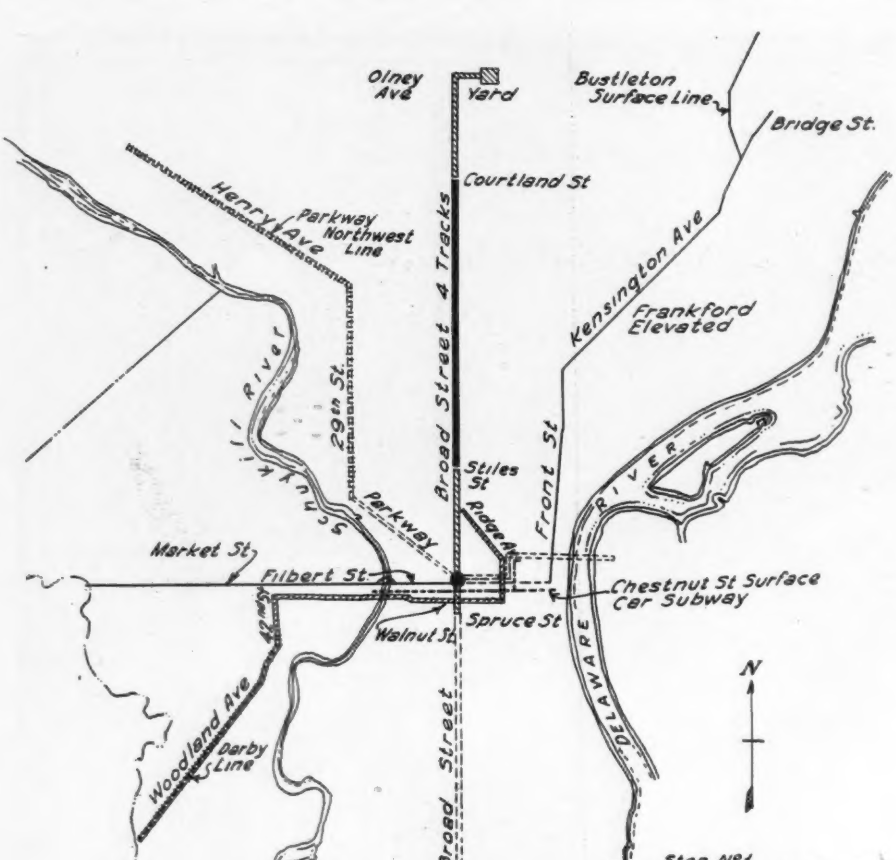
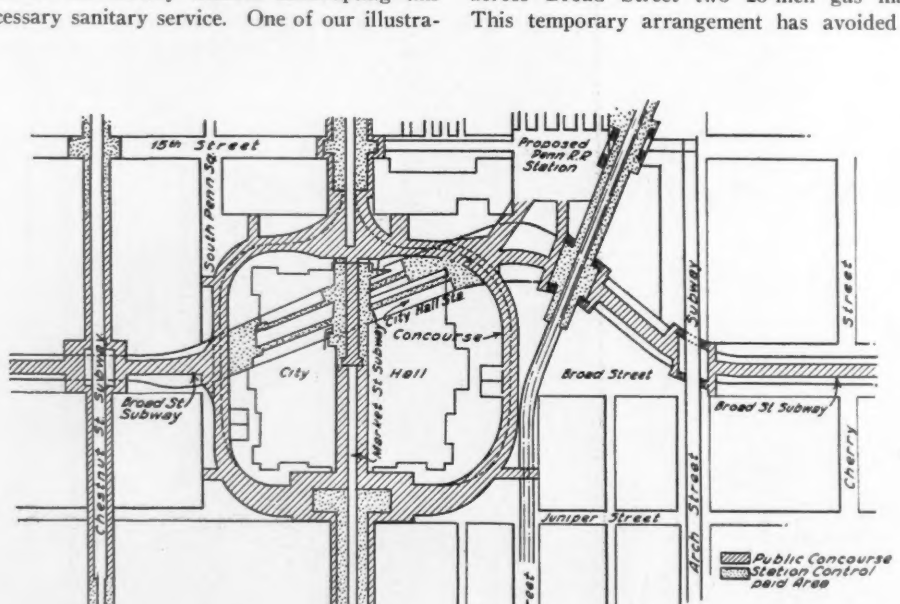


Diagram of authorized Rapid Transit System indicating sections of project now under construction and forming part of Step No. 1.



Study plan of public concourse around City Hall showing how the existing Market Street Subway and the Broad Street Subway will interconnect.

arrange a number of big trunk sewers and to run these structures transversely beneath the floor of the subway without interrupting this necessary sanitary service. One of our illustrations shows how the United Gas Improvement Company of Philadelphia has carried overhead across Broad Street two 20-inch gas mains. This temporary arrangement has avoided the hazard of explosion which is commonly present where live gas mains are maintained in a covered trench—such as the subway is, in effect.

The subway, in the course of its run below the surface of North Broad Street, must pass under railroad crossings at three points. These crossings are made by the railroad in open-cut subways and, therefore, the rapid-transit subway is dug at a correspondingly deeper depth in order to travel beneath them. This has involved carrying the rapid-transit subway to a depth of 49 feet below the street level and has necessitated rather ingenious and exacting steps to support the overlying railroads and bridges at the same time.

As some of our pictures indicate, Broad Street has been decked over with 5-inch planking wherever the underlying ground has been excavated in pushing forward the subway sections now in hand. The practice with one contractor is to excavate the entire width of the street as he goes on and to plank it over from curb to curb, while the other contractor excavates and planks over only half of the width of the street at a time. Again, in bringing the excavated material to the surface, one contractor raises the spoils by hoists through shafts placed at strategic points and dumps the material into trucks at the street level. The other contractor has provided a series of ramps at suitable points in the middle of the street so that a fleet of trucks can run right down into the hole and be loaded underground. As might be expected, the two procedures call for different methods of operation; and each contractor is satisfied with the way he is dealing with his problem.

The terminal yard, which will be made ready by the time the Broad Street Subway is finished, will occupy a site containing an area of 31 acres. It is planned to provide there ultimately storage room for approximately 450 cars; and within this reservation there will be assembled shop facilities which can take care of the work incidental to repairing and maintaining about 600 cars. So much for the principal features of this momentous undertaking which will inevitably prove a boon to the people of Philadelphia.

In the Annual Report for 1923 of the Department of City Transit appeared the following illuminating paragraph which explains in part the conditions which have compelled Philadelphia to engage in the building of a greatly amplified municipal system of rapid transit. This paragraph applies with nearly equal force to some other of our first-class cities, and, therefore, should prove of widespread interest. "Only a little reflection is needed to show that the inadequacy of transit service, which has been a condition so long that it may be described as chronic, is not the cause of the congestion of our streets but is rather the effect of it. *The congestion of city streets is actually caused by the intensive and unregulated development of real estate by the owners.*

"Our 50-foot streets, provided in the plan of William Penn, with 2- and 3-story buildings abutting thereon, were supposed to correspond. But those buildings have given way to steel-

frame skyscrapers of towering height, and in the case of most streets no increase in width or area has resulted." This means that the flanking structures, with their incidental increase in activities and associate augmenting of pedestrian and vehicular traffic, have virtually bottlenecked movement both on sidewalks and driveways. Inasmuch as the architectural tendency is to put up higher buildings, as a rule, it is manifest that relief can be obtained only by constructing subways or by rearing elevated lines of rapid transit. In sections where narrow streets prevail the subway system is preferable for many reasons.

An especially significant development in the case of Philadelphia—possibly a duplication of the trend elsewhere—has been the ascertained unprecedented growth of the riding habit. Experts, basing their figures upon carefully compiled data, estimated that the full tide of the per capita riding habit in Philadelphia would not be reached until 1960, when each citizen would indulge in 400 rides in the course of a twelvemonth.

How big gas mains are temporarily carried above Broad Street. This arrangement keeps the mains out of the open trench where leakage might lead to serious if not damaging explosions.

To quote again from the 1923 report of the Department of City Transit: "Up until 1915 the growth of riding per capita seemed to follow a general law that traffic increased at a somewhat more rapid rate than the population. Since 1915 the growth of traffic has been much accelerated; and today the supposed upper limit of 400 rides per capita is nearly reached —notwithstanding the handicap of a higher fare than prevailed when the original forecast was made."

Philadelphia is amply justified in obligating itself to expend more than $110,000,000 in the carrying out of Step No. 1. As Mr. Ehlers has expressed it: "The providing of these lines will add not only to the comfort and the convenience of the public but they will aid greatly in the general development of the city. Although under present conditions lines of this character are not ordinarily expected to earn a full return on their cost during the early years of operation, they do result in an immediate benefit to the community and to the development of the city in sufficient measure to justify the necessary investments. The execution of this high-speed transit program is well underway, and will be carried forward with continued dispatch. The Department of City Transit is earnestly striving to carry out Mayor Kendrick's slogan of 'Action and Coöperation.'"

(To be Continued.)

NEW DATA ABOUT QUENCHING STEEL SHAPES

A RECENT issue of *Technical Bulletin* contains the following interesting facts discovered by the Bureau of Standards after certain researches having to do with initial temperature and mass effects in quenching steel shapes.

The bureau has been studying the rates of cooling at the centers of various sized spheres, rounds, and plates of steel immersed in different media, such as air, oil, water, and 5 per cent. sodium hydroxide. The effect of the quenching temperature upon these cooling velocities has also been investigated.

A definite relationship has been found between the surface per unit of volume (or weight) of any of these shapes and the cooling velocity obtained at their centers when they are cooled in the different media. These relationships can be expressed by simple mathematical equations and are of a hyperbolic form, which is close to a straight line for air and becomes more curved as the cooling becomes more drastic.

When the three shapes mentioned have the same surface per unit of volume they will have the same center cooling velocity when they are quenched in the same coolant from the same temperature.

Charts have been worked out so that if the rate of cooling at the center of any of these simple shapes is known, when quenched from any temperature in nearly any of the common coolants, the rate of cooling can be computed for any shape from very small to moderately large dimensions when it is quenched from any temperature between 720 and 1,050°C. (1,330 to 1,920°F.) in the same medium.

If the cooling velocity which will completely harden any of the carbon steels is known, this information will give the maximum size of any of the simple shapes which will completely harden to the center in nearly any of the common cooling media.

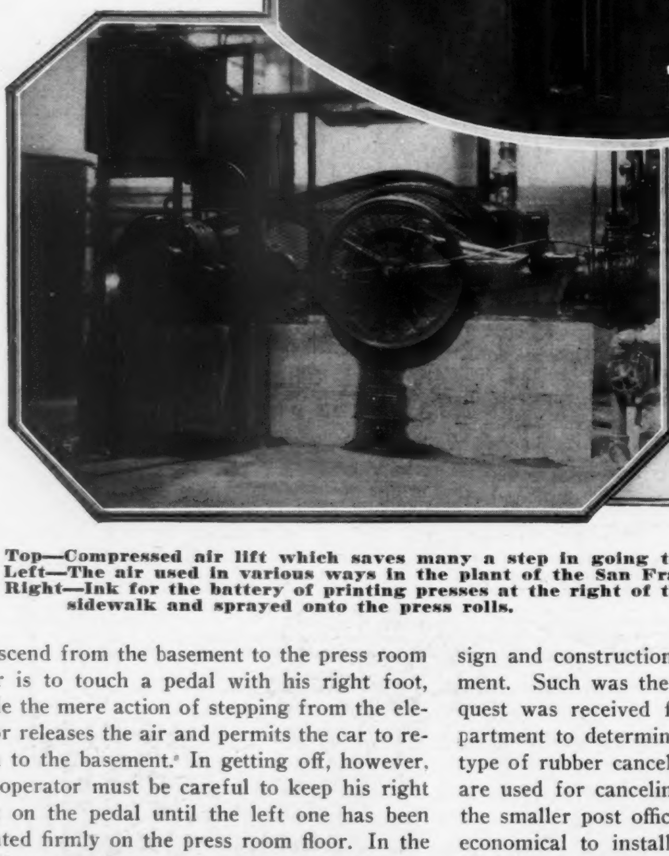
A quart of Friday's milk, in a thermos bottle, sent by air-mail from San Francisco was received in New York on Saturday and then forwarded by special delivery to Atlantic City, where it arrived in good condition on Sunday morning. The package weighed about five pounds and the postage charges were $16.20, exclusive of the special-delivery stamp.

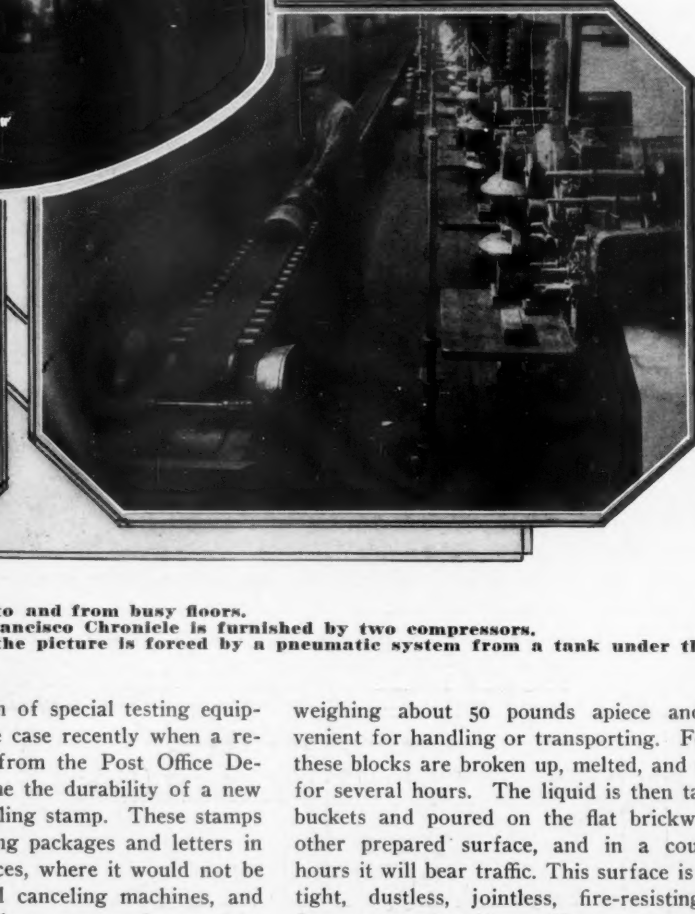
Transverse section of the Broad Street Subway showing essential features and giving principal dimensions.

TIME AND STEPS SAVED BY COMPRESSED AIR

IN THE plant of the *San Francisco Chronicle,* one of San Francisco's leading newspapers, two I-R compressors provide air for various purposes. The supply of ink, for instance, which is kept in a tank under the sidewalk, is forced through pipes by compressed air to each of the 28 ink fountains on the 14 "black" presses. Each fountain has its own floating feed by which the contained ink is maintained at a constant level. The ink is sprayed on the full length of the first roll, which spreads the printing fluid evenly over the stereotype plates.

One of the features of the plant, which goes far towards saving steps, is a number of lifts or elevators between the basement floor, where the paper reels are run off, and the press room above. These elevators are just large enough to carry one person, and are operated by compressed air. All that the passenger has to do to cause the lift





Top—Compressed air lift which saves many a step in going to and from busy floors.
Left—The air used in various ways in the plant of the San Francisco Chronicle is furnished by two compressors.
Right—Ink for the battery of printing presses at the right of the picture is forced by a pneumatic system from a tank under the sidewalk and sprayed onto the press rolls.

to ascend from the basement to the press room floor is to touch a pedal with his right foot, while the mere action of stepping from the elevator releases the air and permits the car to return to the basement. In getting off, however, the operator must be careful to keep his right foot on the pedal until the left one has been planted firmly on the press room floor. In the mailing room there are two more such air-operated lifts. One of them delivers bundles of *Chronicles* to the newsboys' room below, where the boys are waiting to hurry out on the streets with their papers, and the other lowers stacks of newspapers into the adjoining carriers' room.

The value of the mineral output of the Territory of Alaska since 1880 has reached a total of $535,084,276.

ADDING TO DURABILITY OF RUBBER STAMPS

RUBBER stamps have many fields of usefulness, and it has been long felt in some directions that substantial economies could be realized if stamps of this sort could be so made that they would continue to make clean-cut impressions during a greater length of service. The U. S. Bureau of Standards has been investigating this subject, and the following information was made public by it in a recent issue of *Technical Bulletin.*

The bureau is many times called upon to make tests to determine the durability of articles of manufacture which require the design and construction of special testing equipment. Such was the case recently when a request was received from the Post Office Department to determine the durability of a new type of rubber canceling stamp. These stamps are used for canceling packages and letters in the smaller post offices, where it would not be economical to install canceling machines, and in the larger offices for use on packages of irregular shape.

The new type of stamp is of more flexible construction than those previously used and was designed to produce a more legible postmark with less pressure. A special machine was constructed to test out these stamps in comparison with the older type. It consisted essentially of an arm, to which the stamp was secured, so controlled by means of cams and levers that the stamp automatically struck first the ink pad and then a strip of paper. The paper was fed along slightly after each stroke of the machine, so that separate impressions were made.

The new type of stamp proved to be superior to the older type, and after 1,000,000 impressions, which required two weeks of continuous operation, the stamp still produced a legible postmark, and no weakness in its construction was apparent. This performance would be equivalent to several years of ordinary use.

"ROCK ASPHALTE"

SUCH is the trade name of a fine paving or flooring material which is being produced in large quantities by an English firm. It consists of a limestone aggregate impregnated with, or embedded in, a high-grade bitumen or natural pitch, the approximate proportions being 85 per cent. limestone and 15 per cent. bitumen. The rock is ground to powder; "cooked" with the bitumen; and then run out through a molasses valve into molds, forming blocks weighing about 50 pounds apiece and convenient for handling or transporting. For use, these blocks are broken up, melted, and cooked for several hours. The liquid is then taken in buckets and poured on the flat brickwork or other prepared surface, and in a couple of hours it will bear traffic. This surface is watertight, dustless, jointless, fire-resisting, and forms a comfortable, resilient, non-conducting floor. Contrasting patterns of various colors are easily produced with it.

At a recent meeting in Atlantic City, Pa., cold-storage warehousemen took steps towards the establishment of a set of standard warehouse forms which would be specifically applicable to the cold-storage industry. A committee was formed to survey the existing conditions.

Car-Building Contests Held by the Delaware and Hudson Company Have Proved of Value

FOR THREE successive years, the Delaware & Hudson Company has staged at Carbondale, Pa., car-building or car-assembling contests which have aroused enthusiasm among the personnel of the company and created much interest generally. These contests have been attended by representatives of the Interstate Commerce Commission, by railway supply men, by newspapermen, and by writers for technical and mechanical publications.

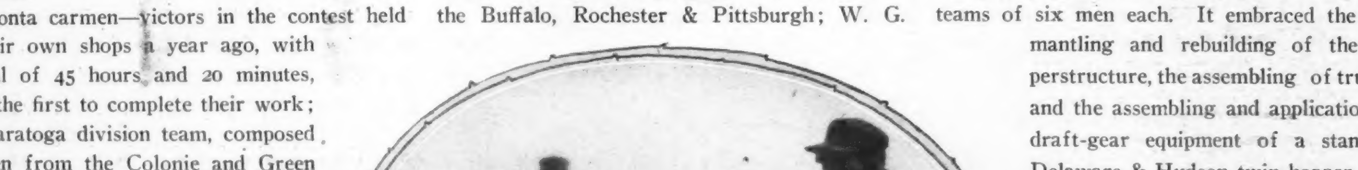
At the contest held this year there were present nearly 1,000 spectators; and three competing teams—each made up of sixteen men, vied with one another for championship honors in the assembling of three Delaware & Hudson standard, tandem, twin-hopper-bottom gondola cars, each of 85,000 pounds capacity. The following account of the recent competition has been taken from *The Delaware and Hudson Company Bulletin*. It should prove of especial interest to a goodly number of our readers because of the part played by air-driven tools in the exciting and somewhat spectacular performance.

Mr. J. T. Loree, Vice-president and General Manager, awarding the Birkett cup to A. G. Ditmore, Divisional Car Foreman of the Susquehanna Division.

Oneonta carmen—victors in the contest held at their own shops a year ago, with a total of 45 hours and 20 minutes, were the first to complete their work; the Saratoga division team, composed of men from the Colonie and Green Island shops, finished second with 46 hours and 24 minutes; and the Carbondale team, with 48 hours and 32 minutes, was third. All time calculations were made on the basis of man-hours. C. E. Peiffer, master car builder for the Buffalo, Rochester & Pittsburgh; W. G. Knight, mechanical supervisor for the Bangor & Aroostook; and P. Alquist, master car builder for the Delaware, Lackawanna & Western were the judges.

New interest was afforded and the contest was made more formidable than any of its forerunners by the inclusion of the regular steelwork, which is a part of the building program as applied to such cars. The make-up of each team therefore included eight steel and eight woodworkers, although at no time were more than eight men of either classification at work. Because of a desire not to "overload" the teams, the air-brake work and the painting and stenciling of the car were left for Carbondale employees to complete after the official contest operations had been concluded.

As each such contest is announced, the sphere of prominence which these demonstrations have created for themselves in the railroad world, because of their highly educational features, is noticeably increased. The first was held at our Colonie shops, October 31, 1923, and was participated in by five teams of six men each. It embraced the dismantling and rebuilding of the superstructure, the assembling of trucks, and the assembling and application of draft-gear equipment of a standard Delaware & Hudson twin-hopper gondola car of 85,000 pounds capacity. A Carbondale team won, its total of man-hours being 46 hours and 54 minutes. The second was at Oneonta, May 8, 1924, at which time the superstructure of a 60,000-pound-capac-



Oval—Bucking up rivets with a hand dolly.
Left—Driving center-sill rivets with a 6A riveting hammer.
Right—Driver bucking up his own rivets with a foot-operated dolly bar.

The Oneonta carmen who again proved victorious.

ity steel-underframe box car was built and trucks and draft gear assembled—an Oneonta team winning in 52 man-hours.

The runners-up, the men of the Colonie team who finished second in this year's contest.

Rivalry among the participating workmen is friendly, but nevertheless keen. There is always an evidence of shop pride and an earnest desire to carry back with them the trophy of the day, the Birkett cup, a silver memorial to the first car foreman employed by the company. The contests, ostensibly, are planned for the educational features they may develop. Outstanding among these is the material layout, indicating, as it does, efficient and economical shop operation: the ready accessibility of material stimulating production and the resultant output being reflected in the earnings of the pieceworkers, on which basis the work is performed.

Work commenced promptly with the blowing of the shop whistle at 8 a. m. From then on until the last nut was run down on the prize-winning car and the judges had turned it over to G. W. Ditmore, master car builder, there was only one interruption in the performance, and that was of 10 minutes' duration following the conclusion of the steelwork on each car, thereby providing time in which to clear the space around the car so that the woodworkers might progress with their tasks unhampered by litter or other obstacles.

Almost from the very outset, a difference in the method of approach was noticeable on the part of each team. The most noticeable variation in the steelwork was that the teams from Colonie and Oneonta allowed the center channels to lie flanges down on the horses upon which they rested until side castings and reinforced channels had been secured, which appeared to be the best practice. Carbondale workers, in consummating this same performance, kept the channels on edge—thus making it necessary to steady them while the operations noted were in progress. Another feature of the steelwork which attracted considerable attention was a home-devised lever dolly bar used by a Colonie riveter, which permitted him to hold a rivet and buck it up at the same time. Numerous other kinks and unique practices, which were wholly permissible, were noticeable in the completion of the steelwork as well as in that of the wooden superstructure.

Colonie was the first to conclude its steelwork, finishing at 9.57 a. m. Oneonta was second, at 10.05 a. m., and Carbondale third, at 10.50 a. m. Explanation of the wide divergence of time, particularly as between that of the Carbondale team and the other two, is to be found in an agreement, made between the three divisional car foremen prior to the contest, that permitted them to assign the truck work to either their steel crew or to the woodworkers.

In regular shop practice, truck repairers do this work; but these were omitted from the teams for the same reason as were the air-brake men and painters. Carbondale chose to have its steel men also assemble the trucks; and the judgment of the foreman,

The Carbondale team that finished third in the exciting contest.

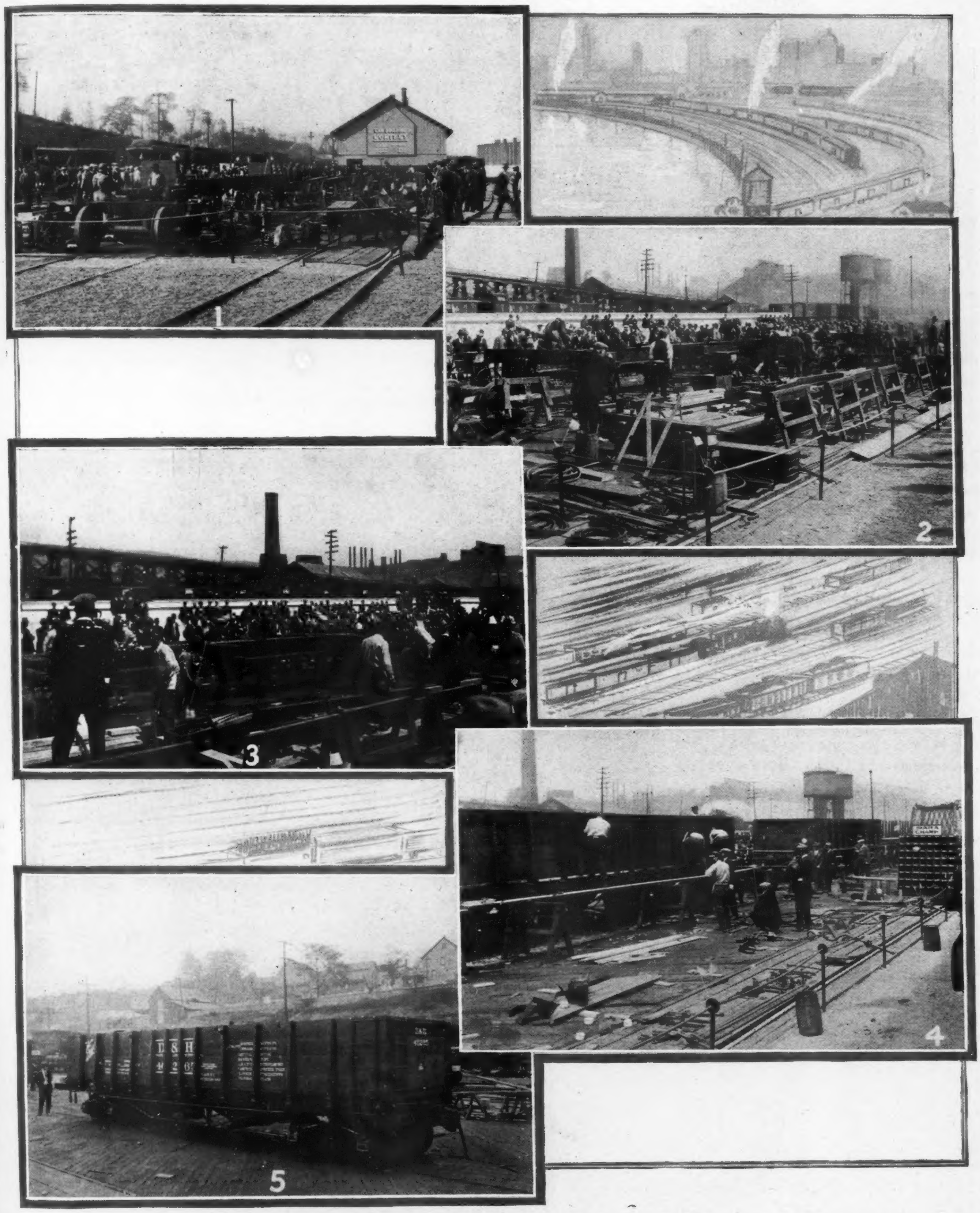


Fig. 1—The stage all set for the third annual car-building contest at Carbondale, Pa.
Fig. 2—Contest underway with the competing teams busy fitting up the underframe steelwork of the cars.
Fig. 3—The completed underframe of the car being assembled by the Colonie team.
Fig. 4—Woodwork nearing completion on car being assembled by the Colonie team.
Fig. 5—Ready for the road: the car put together in record time by the winners, the Oneonta team.

Left and center—Driving rivets in different parts of the underframe of a hopper car with powerful SA riveting hammers. Right—Reaming holes in the steel underframe of a hopper car with what is known as a Size "B" drill.

Raymond Schuster, would have proved its worth but for difficulties experienced in the performance of the steel assembling. It was his idea that he could thus effect a better equalization of his men, for when certain of them no longer were needed on the steelwork they could be used on the trucks. Oneonta and Colonie left the trucks to their woodworkers.

Differences in practices among the woodworkers were noticed in the manner in which they handled their side sills. Colonie, it was agreed, used the best method, that of allowing the sills to lie flat on horses until stake pockets had been secured by U bolts, after which the sills were turned over and nuts run down by air machine. Portable scaffolding appeared an advantage to the Oneonta team over the use of ladders by their competitors when bolting side stakes and corner bands, and in securing Wine ladders and other outside appliances.

Oneonta finished its woodwork first, at 1.30 p. m.; Colonie was second, at 1.38 p. m.; and Carbondale third, at 1.54 p. m. For better time comparisons see one of the accompanying tables. Time required for the assembling of trucks and the assembling and application of draft gears is included in the woodwork time of the Oneonta and Colonie teams and in the steelwork time of the Carbondale team, as follows:

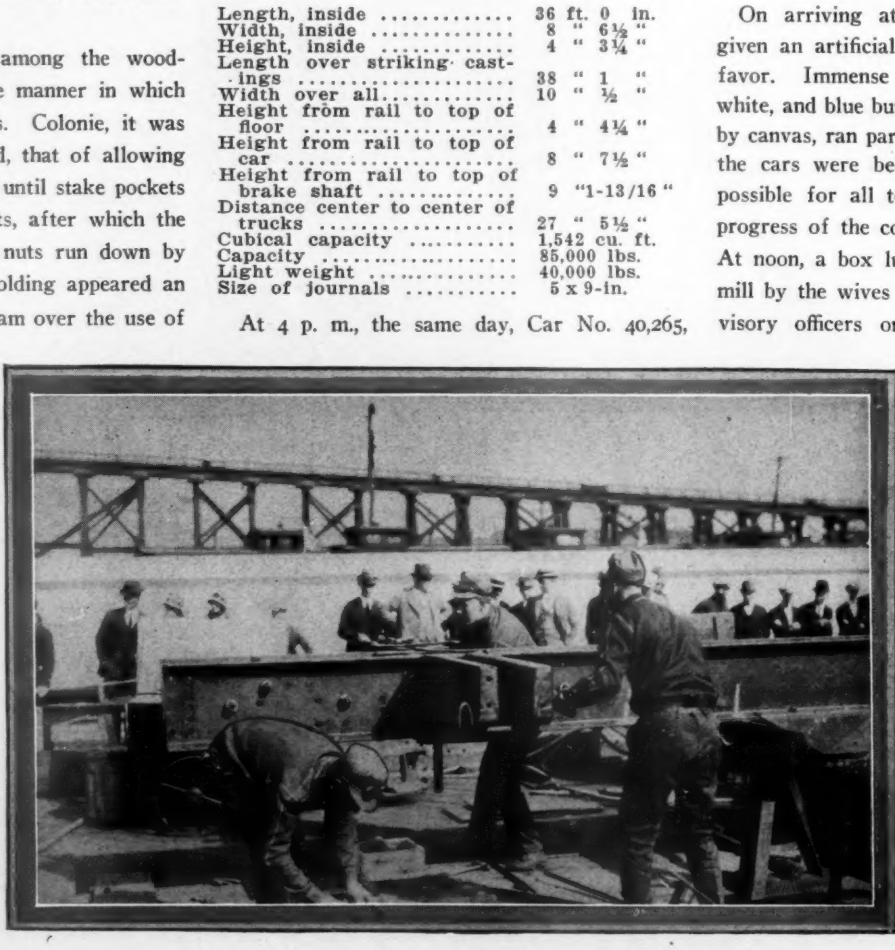
	Oneonta hr.	Oneonta min.	Oneonta sec.	Colonie hr.	Colonie min.	Carbondale hr.	Carbondale min.
Trucks	1	..	..	1	44	2	28
Draft gears assembled and applied	..	39	34	1	4	..	54

The dimensions of the type of car in question are:

Length, inside	36 ft. 0 in.
Width, inside	8 " 6½ "
Height, inside	4 " 3¼ "
Length over striking castings	38 " 1 "
Width over all	10 " ½ "
Height from rail to top of floor	4 " 4¼ "
Height from rail to top of car	8 " 7½ "
Height from rail to top of brake shaft	9 "1-13/16 "
Distance center to center of trucks	27 " 5½ "
Cubical capacity	1,542 cu. ft.
Capacity	85,000 lbs.
Light weight	40,000 lbs.
Size of journals	5 x 9-in.

At 4 p. m., the same day, Car No. 40,265, completed by the Oneonta team, was loaded at the Coalbrook breaker across the yards from the scene of the contest, and 55 minutes later was en route for Wakefield, Mass., via the Boston & Maine, in Extra 1219, north.

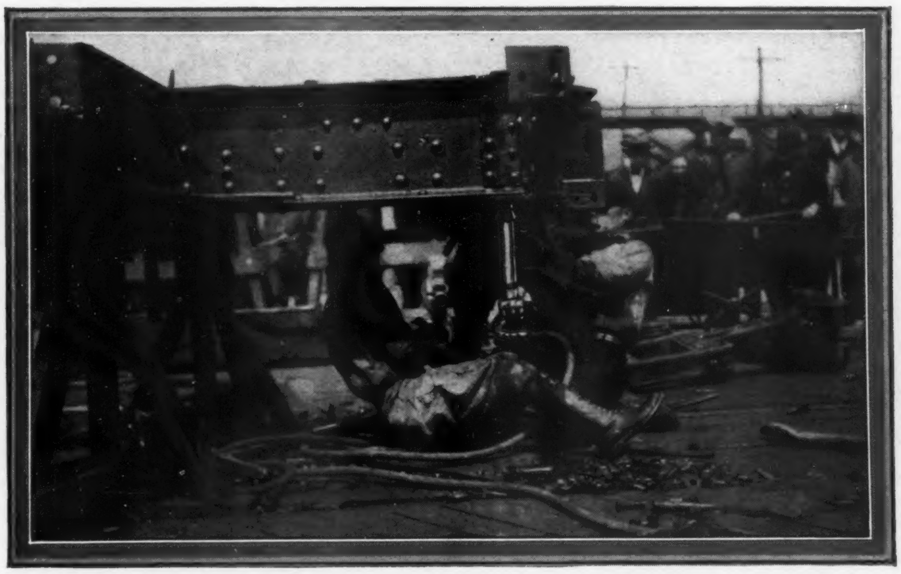
On arriving at Shop 26, each guest was given an artificial red flower to be worn as a favor. Immense bleachers, trimmed in red, white, and blue bunting and with seats protected by canvas, ran parallel to the tracks upon which the cars were being built, thereby making it possible for all to watch, at close range, the progress of the contest from beginning to end. At noon, a box lunch was served in the wood mill by the wives of the car-department supervisory officers on the Pennsylvania division and by the young ladies in the divisional car-foreman's office at Carbondale.



Oneonta steel gang fitting up a car underframe.

G. W. Ditmore, master car builder, announced the results of the contest and congratulated the men upon the spirit with which they had taken part in it, and then Colonel J. T. Loree, vice-president and general manager, who with his staff had interrupted an inspection trip over the system to watch the contest throughout, spoke of its educational benefits and commended the men upon their splendid ac-

complishment. He thereupon returned to A. G. Ditmore, divisional car foreman on the Susquehanna division, the Birkett cup which had been won a year ago by men from his shops and the possession of which had been at stake during the progress of the contest. In conclusion, he presented $20 gold pieces to the members of the winning team, while to those on the second team he gave $10 gold pieces. He announced that another contest would be held either this fall or next spring.



Driving rivets in an awkward position in the steel underframe of a car.

PNEUMATIC TOOLS USED IN THE CAR-BUILDING CONTEST.

Woodboring Machines	Size DD	Ingersoll-Rand
" "	No. 13	"
" "	No. 15	"
" "	Size 31	Thor
" "	No. 00	"
" "	No. 11	"
Riveting Hammers	No. 6A	Ingersoll-Rand
"	No. 8A	"
Air Drills	CSB	"
"	BS	"
Reaming Machines	CCSB	"
"	CCW	"

Reaming Machines fitted up with sockets for tightening nuts.

BETTER INKS

THE INKS which we have been using in these later years, both for writing and for printing, have been incomparable with those of the ancients for permanency, stability of color, and non-corrosiveness, and as a result many of our valuable records will have become illegible when they might prove of most importance. Great improvements, however, have been made in ink manufacture. Now we employ carbon black instead of lampblack for printing ink, and in the case of writing ink we are actually going back to the materials utilized 1000 years ago. Then inks were made of plant juices which, instead of fading, darkened with age and exposure.

Today, employing gas-fired closed cauldrons, a strong extract is made from Aleppo nut galls, imported from Asiatic Turkey, which a leading ink manufacturer is said to use exclusively. The extract of the nut galls is boiled at about 329° F. for two hours. Marking ink, with special permanency, is first made in concentrated form, and then the ingredients are heated by gas to 284° F. The temperatures given correspond to steam pressures of 100 pounds and 50 pounds, respectively.

RECORDS MADE BY THE COMPETING TEAMS.

	Oneonta		Colonie		Carbondale	
	hr.	min.	hr.	min.	hr.	min.
Steelwork	16	40	15	36	22	40
Woodwork	26	..	28	8	23	12
Total	42	40	43	44	45	52
Air-brake work	1	10	1	12	1	5
Painting and stenciling	1	30	1	28	1	35
Finished time: man-hours	45	20	46	24	48	32

EARLY POWER PUMPING

AN exhibition of models covering the field of water power and pumping during the period between the fifteenth and the eighteenth century was held recently in the City of Augsburg, Germany. Existing local records along the same line extend much farther back than this. Mills driven by water power existed in Augsburg as early as the eleventh century, and six were in operation in the year 1276—this number increasing tenfold in the five years following.

Air-driven woodborers and reamers speeded up operations at critical moments in the contest.

TESTING SKYSCRAPERS IN MINIATURE

By S. R. WINTERS

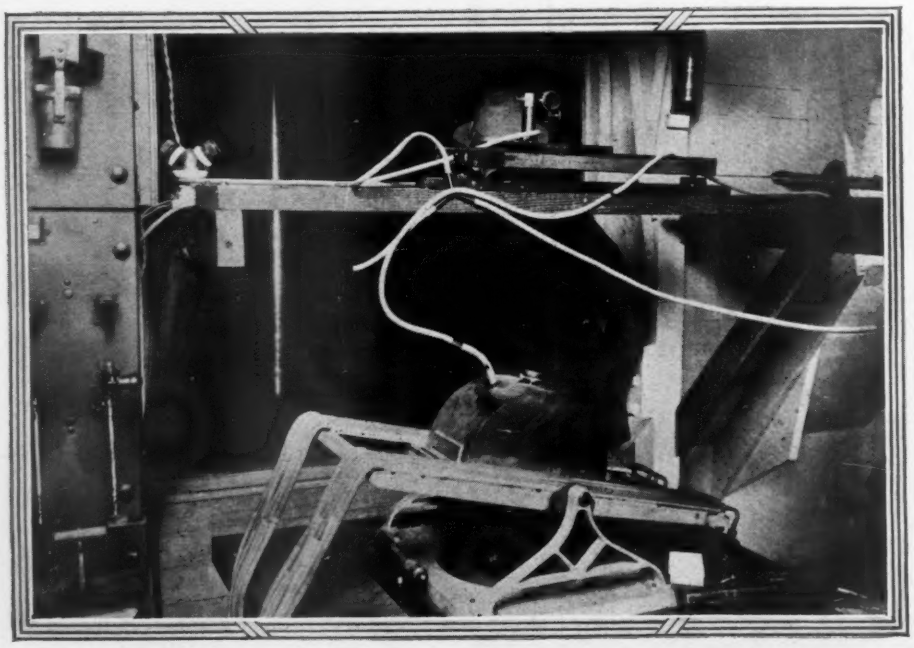
THE fabled old woman who, with her children, lived in a shoe would seem to have had spacious accommodations compared to housing a skyscraper in a tunnel ten feet in diameter. However, the building in question is in miniature, and was constructed by the United States Bureau of Standards to test the effect of wind pressure on towering structures. Similarly, the model of a tall chimney is being put in the air tunnel and subjected to winds ranging in speeds from 30 to 70 miles an hour —the tendency of either one of the buildings to topple indicating structural weakness, or, oppositely, structural strength being indicated by their capacity to withstand pressure.

The object of these interesting tests, conducted under the supervision of Dr. Hugh Dryden of the Bureau of Standards, is to determine whether or not it would be safe to lower the present building standards for skyscrapers, etc. Tall buildings are now erected to withstand a wind pressure of 30 pounds per square foot of exposed surface, while chimneys are made to resist a pressure of from 20 to 25 pounds. Statistics show that winds traveling at a rate of 76 miles per hour are rare. Even at that velocity the pressure exerted would be only 24 pounds per square foot of wall surface. Tornadoes, which attain a speed in excess of 100 miles an hour, were not taken into consideration in making the wind-pressure tests, inasmuch as the cost of a structure capable of withstanding such a destructive force would be prohibitive, even if it could be built.

Courtesy, Bureau of Standards.

The 10-foot wind tunnel in which miniature skyscrapers are being subjected to a series of interesting tests to determine the effect of wind pressure on such structures.

For the purpose of the experiments, the side surfaces as well as the top of the model skyscraper—which is 8 inches square and 24 inches high—are perforated with numerous small holes. The model is rotated so that the wind can strike it at every angle. Once placed inside the tunnel there are attached to ten of the holes as many tubes, each of which leads to a pressure gage. These tubes, as well as a connecting tank, are filled with kerosene; and by variations in the movement of the liquid in these tubes the wind pressure is indicated.



© Harris & Ewing, Washington, D. C.

Some of the equipment used by the Bureau of Standards in making the wind-pressure tests.

These novel tests were inspired by numerous inquiries received by the Bureau of Standards from designing engineers, insurance companies, and others interested in lowering the rigid requirements now specified for tall buildings that are to withstand 30 pounds wind pressure per square foot. The failure, in 1879, of the Tay Bridge, a railroad span across the Firth of Forth, England, may be said to have figured largely in setting the present wind-pressure standards for structures—that disaster having exacted a tremendous toll of life.

If the results of the model tests establish, as is believed by experts, that a reduction can be made in the present stress standards, then building costs could be lowered.

JOHN F. HAIGHT

WE regret to announce the death in Phillipsburg, N. J., on August 31, of "Jack" (John F.) Haight at the ripe age of 85. Through this sad event the Ingersoll-Rand Company has lost another of its valuable old employees.

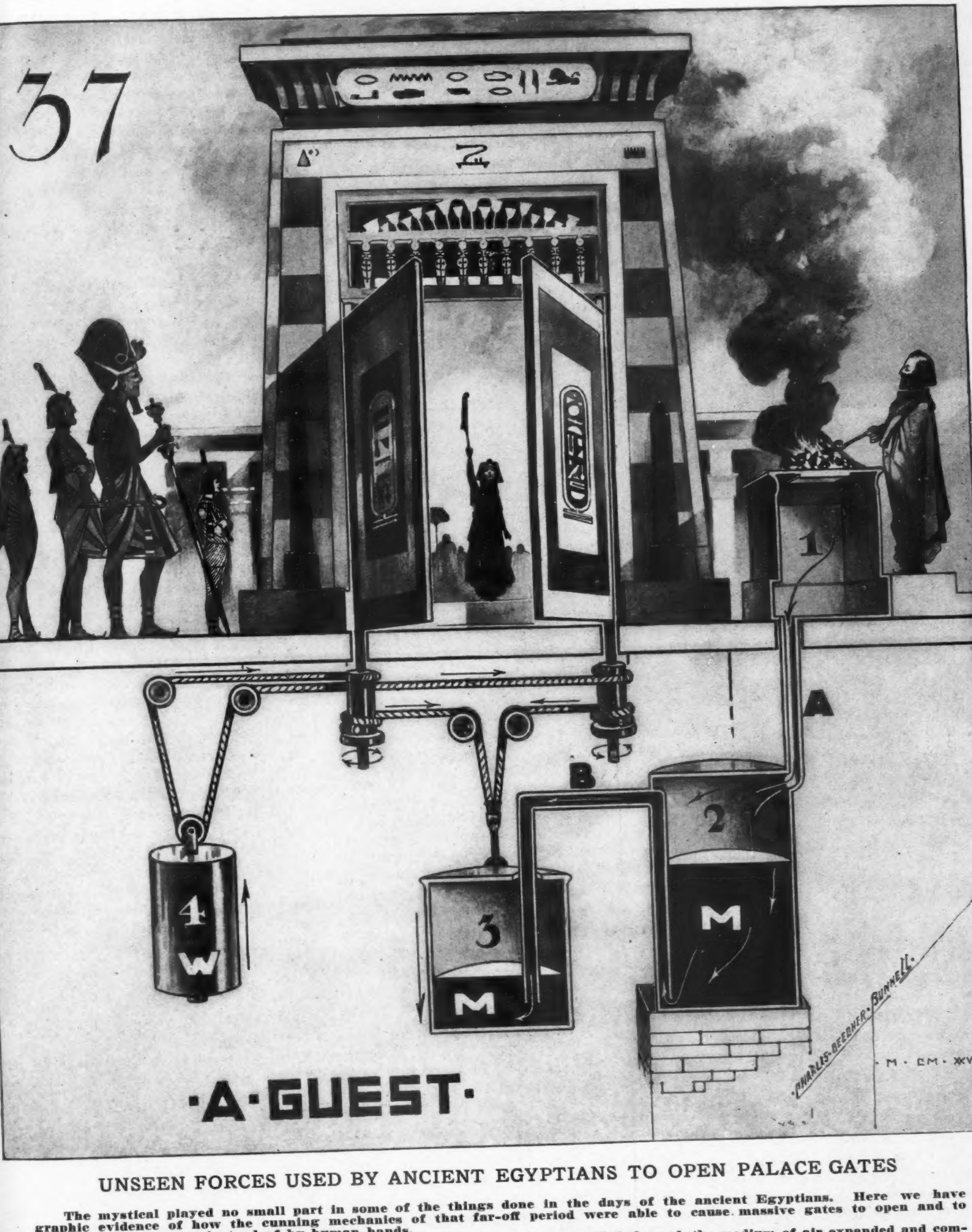
Mr. Haight was closely associated with the application, the manufacture, and the testing of rock drills and allied equipment for a long period going back to the days before the New York aqueduct. During the greater part of this period he was first connected with the Ingersoll-Sergeant Drill Company; and at the time of his death he was with the Ingersoll-Rand Company.

Many of the leaders in the actual operating of mining, tunneling, and quarrying equipment owe much of their knowledge to the assistance rendered and the instruction imparted to them by Jack Haight, who was always and at all times anxious to be of help to the industry. His popularity among these men throughout the entire United States was tremendous; and we know that his numerous friends will learn of his demise with deep regret.

Mr. Haight is survived by his wife and two children.

RADIO LOCATES ORES

ASTONISHING demonstrations of the use of radio in locating sulphide ores and in tracing the position and course of fault lines at Darwin, a famous lead district of California, are described by W. R. McCrea in the *Nevada Mining Press.* Mr. McCrea is operating the LeMoine lead mine some 50 miles north of that camp. The application of radio to this use has been worked out by an Arizona professor, and the demonstration is astonishing. Both sending and receiving ends of the radio are used, and the ground wire is grounded to galena. A corps of radio men have been on the spot for six weeks and they have plotted the entire district. The results accomplished are expected to stimulate metal mining throughout this region.



UNSEEN FORCES USED BY ANCIENT EGYPTIANS TO OPEN PALACE GATES

The mystical played no small part in some of the things done in the days of the ancient Egyptians. Here we have graphic evidence of how the cunning mechanics of that far-off period were able to cause massive gates to open and to close by hidden forces instead of by human hands.

Hero, in his 37th Proposition, discloses how palace gates were controlled through the medium of air expanded and compressed by heat. When a guest approached the palace gates, the guardian of the portal revived a smoldering fire or started a new one into vigorous flame upon a bronze box or altar, 1. The fire heated and expanded the air within the box and caused the air to be forced downward through pipe, A, into the upper part of a tank, 2, containing mercury, M. The compressed air acted upon the free surface of the mercury sufficiently to raise the mercury through the siphon, B, and discharged the mercury into an iron pail, 3. When the accumulating weight in the pail exceeded that of the counterweight, 4-W, the pail descended and pulled down on ropes that engaged spools on the two shafts on which the doors were hung—gradually and impressively swinging the doors open. When the fire was quenched, and the cooling of the air had induced condensation in box 1 and tank 2, the mercury was sucked back into tank 2. When this reaction had continued long enough, the couterweight once more predominated and pulled oppositely on the spools so as to close the doors.

Compressed Air Magazine

—*Founded 1896*—

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Business and Editorial Offices:

Bowling Green Building, No. 11, Broadway, New York City. Tel. Bowling Green, 8430

Publication Office: Somerville, New Jersey

TERMS OF SUBSCRIPTION

$3 a year, U. S. A., American possessions and Mexico; all other countries $3.50 a year, postage prepaid. Single copies, 35 cents. Back issues more than six months old, 75 cents each.

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EDITORIALS

ART OF SUBWAY BUILDING ADVANCES RAPIDLY

DIGGING subways in a densely built-up city is inevitably filled with engineering problems that call for expert handling. But the longer the construction of such rapid-transit arteries is delayed the greater become the difficulties because of the character of flanking buildings and the presence of many underground conduits that must be displaced and disposed of elsewhere with the least practicable inconvenience to neighboring citizens, industries, and businesses. Furthermore, postponement only adds to the need of greater dispatch in carrying on the work so that normal surface traffic may be hampered for as short a while as possible.

In our current issue appears the first installment of three articles dealing with steps being taken as well as projected by the City of Philadelphia to provide relief from traffic conditions that have latterly become extremely congested. North Broad Street, where the major part of the present undertaking is situated, is a wide thoroughfare over which flows daily to and fro a heavy tide of vehicular traffic. It has, accordingly, been a matter of prime concern that operations both above and below ground should be carried on in ways that would least hamper this movement and that would make it feasible to complete the subway sections with exceptional dispatch.

Up to date, progress has been at a very gratifying rate notwithstanding the fact that the contractors have had to remove much rock and to rearrange sewers and a rather complicated network of gas and water mains, not to mention telephone cables and high-voltage electric transmission lines. This progress has been made possible largely by utilizing compressed air to run power shovels, rock drills, clay diggers, pneumatic hoists, woodborers, riveting hammers, etc. Some of these facilities have never before been used on such a scale in any kindred project, while certain other of the air-driven equipment have thus been used for the first time. Here we see how the subway builder has cast about him and drawn to his aid the tools and the machinery which have proved capable and efficient in other lines of endeavor.

LONGEST TUNNEL TO PIERCE CASCADE RANGE

THE example set in driving the Moffat Tunnel through the Rocky Mountains west of Denver has inspired the citizens of the State of Washington to organize an association bent upon driving a 30-mile tunnel through the Cascade Range so as to provide for three big trunk lines a shorter route between the eastern and the western halves of that enterprising state.

The scheme was originally conceived by Gen. H. M. CHITTENDEN, an army engineer, stationed at Seattle until he died eight years ago. This far-seeing expert was responsible for the plan of the ship canal which links Lake Washington with Pudget Sound and thus places Seattle in touch with the Pacific Ocean via the Strait of Juan de Fuca.

When General CHITTENDEN saw work on the Lake Washington Ship Canal underway, he turned his attention to similarly helping rail transportation within the state. He promptly realized that the somewhat circuitous routes necessarily followed by the transcontinental lines traversing the state could be shortened only by piercing the obstructing Cascade Range. Before he could definitely settle upon the most desirable route and before he was able to arouse sufficient public support in behalf of the scheme General CHITTENDEN died. Others have now revived the project and are bending their energies towards getting the tunnel started.

If the CHITTENDEN plan be adhered to, the tunnel would be 30 feet wide and 25 feet high at the crown of the arch. Assuming the work to cost proportionately not more than other big railroad tunnels that have been driven through the Rockies in recent years, it is estimated that the Cascade Tunnel would involve an outlay of substantially $52,000,000. This figure may be reduced in view of what is now being accomplished in driving the Moffat Tunnel. In the latter undertaking, exceptional and diversified uses of compressed air have notably speeded up advance; and this has been especially marked where powerful rock drills of a new type have been employed.

TIDES OF BAY OF FUNDY TO FURNISH POWER

IF PLANS recently matured by an eminent engineer are carried out, a very considerable section of Maine and neighboring Canada will be able to draw a vast block of electrical energy from the tides of the Bay of Fundy.

The scheme proposed by DEXTER P. COOPER would call into being two great tidal basins formed separately through the sealing of certain passages between islands which now make Passamaquoddy and Cobscook Bays nearly landlocked bodies of water.

The passages would be closed by massive dams of cyclopean masonry provided with locks and gates permitting the regulating of the influx of the rising tide and the outflow of the impounded water during the period of the ebb flow. At that section of the eastern coast there is a difference of 27 feet between low and high water; and if this can be taken advantage of in the way proposed it is estimated that power stations suitably located would be able to develop an aggregate of from 500,000 to 700,000 horsepower!

According to information made public, a force of substantially 5,000 men would have to be employed for five years to construct the enormous gates and dams which would be required to impound the waters of the Bay of Fundy in the manner described; and to carry this magnificent project to completion would involve an expenditure of about $75,000,000.

While it is commonly admitted by critics of the scheme that the project is quite feasible from an engineering standpoint, still the great range of the tide, the exposed position of the coast, and the strength of the currents speeding in and out through the passages between the flanking islands would make the execution of the work extremely difficult and hazardous except under the most favorable conditions—conditions that are likely to prevail during only comparatively short periods in the year. Furthermore, it is said that some of the openings between the islands are fully 200 feet deep; and this gives a hint of the tremendous quantities of rock and masonry which would have to be placed there to effectually seal or control the tidal movements.

On the other hand, a well-known official of a large electrical company is quoted as follows: "Mr. COOPER has found a solution for every problem connected with his scheme. At his invitation, I visited Eastport and made a careful inspection of the tides and the engineering possibility of generating power by them. I am convinced that his scheme is thoroughly feasible."

SELLING MACHINERY ABROAD IN RIGHT WAY

WITH measurable frequency we are reminded that we do not deal with foreigners in the best way when seeking markets for our goods abroad. It should therefore be encouraging to learn from an authoritative source that we can and do win the confidence of foreign buyers when we set about it in the "right way." The following editorial is quoted in full from *Commerce Reports* because of its suggestive valve.

"Consul E. VERNE RICHARDSON reports an nteresting interview with one of the engineers ngaged on the construction of important irri- ation works in India. The subject under dis- ussion was that of American machinery and s employment on these irrigation projects, ut more particularly of the sales methods mployed by American machinery manufac- urers whose equipment had been ordered in rge volume for use in connection with this nterprise. This British engineer, in refer- ng to the American machinery manufactur- s, is reported to have said: 'They have gone bout it in the right way, keeping their own an on the spot to look after their interests.'

"Consul RICHARDSON reports that he was reatly pleased to hear a British engineer, oc- upying a position of importance, refer to an merican manufacturer in this way. Obvious- , it is not easy for American manufacturers keep 'their own man on the spot to look ter their interests' when that spot is in In- a, and it is not easy for the man to stay on e job during the hot season when that spot s an Indian desert. Clearly, the American epresentative of the aforesaid manufacturers ust have been of the right kind when he howed that he was willing to 'stay on the pot' to look after the interests of his principals.

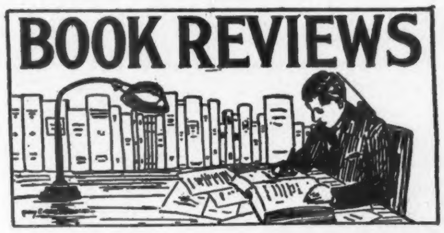
"It appears that, as a result, this particular merican manufacturer has developed a pres- ige that will prove valuable. He has the con- dence of his customers and he does business n the 'right way,' even though the spot is 10,- 00 miles from his factory and in the heart of scorching Indian desert. His affairs are andled by men of the right sort. Salesman- hip of this character will overcome all com- etition; and, when applied in connection with xport trade, is more valuable than is generally ealized."

MOSES H. GOKEY

A CABLE from London on August 29, last, announced the passing away in that ity of Moses H. Gokey, chief mechanic on he erecting staff of the Ingersoll-Rand Com- any. Mr. Gokey, or Mose, as most everyone new him, was well known in America and urope. Born in Canada of French Canadian tock about 65 years ago, he entered the ser- ice of the Ingersoll Rock Drill Company as ar back as 1886.

Mr. Gokey was one of the oldest employees f the company in point of service—one of he "old guard," responsible, with others, for he upbuilding of the company. He was a rained mechanic of rare skill, serving at first n the shops and afterwards out in the field, here his tact and lovable qualities won last- ng friendships. As an erector of large plants e never left the spot until the customer was atisfied. With never a grouch, always cheer- ul even in adversity, he had that saving sense f humor which made him popular with all en.

"Of soul sincere,
In action faithful and in honor clear.
He broke no promise, served no private end.
He gained no title, and he lost no friend."



THE CONSOLIDATION OF RAILROADS, by Walter M. Splawn, Ph.D., Professor of Economics in the University of Texas. A work of 290 pages, published by The Macmillan Company, New York City. Price $3.00.

PROFESSOR Splawn is a member of the Texas Railroad Commission and his training and his association with the problem discussed make him well qualified to express an authoritative opinion upon this important topic. While the problem involved in carrying out the proposed grouping of the railroads of the United States into a limited number of large and comprehensive systems bristles with questions of a highly technical nature, the author has undertaken to explain matters for that much larger circle of readers, the non-technical public, and in this he has succeeded admirably by his lucid and attractive style of presentation.

Professor Splawn traces the genesis of the consolidation idea, shows the purposes behind the Transportation Act of 1920, and keeps the reader from straying into side paths where those that have advanced arguments pro and con consolidation have strayed. This book should be read by a large circle of our citizens, because the topic of rail transportation concerns each and all of us sooner or later.

UNDER THE BLACK FLAG, by Don C. Seitz. A volume of 341 pages, published by The Dial Press, New York City. Price $4.00.

WHATEVER may be the general opinion about seafaring pirates, the fact remains that they were men of enterprise and of abundant courage. Most of them flourished in the days when the hard-fisted, hard-living, hard-drinking sailorman was the type upon which any skipper counted in carrying his craft hither and thither upon the seven seas. Those were the days when romance was rampant in the world of ships, and when even the peaceful merchantman carried a more or less formidable array of cannon, and the commanders of national ships were not indisposed to indulge in what might be termed legalized freebooting.

Mr. Seitz' book is welcome reading for the tired man of business and to some extent is a warning to all persons that may be piratically disposed—no matter what may be their normal occupation or field of endeavor. Within its pages, *Under the Black Flag* gives us a fairly comprehensive history of some thirty unconventional but gallant captains, and tells us what they did and what was done to them on the high seas—when caught. The gentry in question were notable as well as notorious rogues, but they had their admirable qualities, withal.

ANNUAL REPORT OF THE SMITHSONIAN INSTITUTION, 1923. An illustrated volume of 578 pages, published by the U. S. Government Printing Office, Washington, D. C.

AS usual, this annual publication brings together a wealth of authoritative information on many subjects of scientific interest, and most of the topics discussed are presented in a manner which makes them understandable to the so-called average reader. The present volume touches upon topics celestial as well as terrestrial, and they all tell much that is worthwhile. Among the subjects treated are, for instance, the constitution and evolution of the stars; atmospheric nitrogen fixation; the composition of the earth's interior; the natural history of China; life in the ocean; the origin and antiquity of the American Indian; the ruined cities of Palestine; etc., etc.

The Toilers of the Sky, by McFall Kerbey, in *National Geographic Magazine* for August, tells in an indescribably interesting way of the function of the clouds in conveying and in distributing water over the earth.

"Try to count," we are told, "the invisible molecules that jumped out of the sea and traveled perhaps hundreds of miles that you may have your morning quaff. You will bankrupt arithmetic at the start, for it has been estimated that in a third of a thimbleful—a cubic centimeter—of water there are probably more than 32 trillions of billions of molecules."

That must mean 32,000,000,000,000 multiplied by 1,000,000,000, which would give us 32,000,000,000,000,000,000,000. But you really cannot bankrupt the arithmetic until there are no more ciphers, and with the typewriter or the linotype the supply is unlimited.

What the ports of the world are doing and what port experts think, prepared by J. H. Walsh, Construction Corps United States Navy, is published by the Board of Commissioners of the Port of New Orleans, La. This pamphlet is a discussion of port matters with particular regard to the public ownership of public wharves at New Orleans.

The report of a study of the State Highway System of California, prepared by the Highway Advisory Committee, is an illustrated document of 111 pages, containing as an appendix a map showing the state highway system and the status of construction on June 30, 1924. This report is a valuable contribution to an important matter of widespread public interest. It is printed by the California State Printing Office, Sacramento, Calif.

The New Jersey State Highway Commission, Trenton, New Jersey, has recently issued a map showing all the roads improved during 1924 as well as all roads within the state that can be used by motor vehicles. The map is made of further value by illustrations which call attention to important structures and historical points to be met along the various highways. This map is distributed free of charge to any one that will apply for it.

HIGHEST ROTATIVE SPEEDS

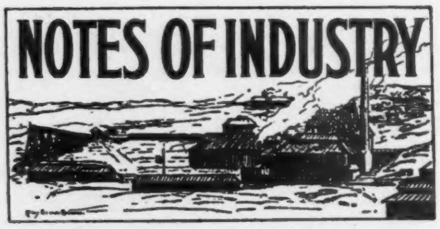
VARIOUS difficulties are encountered in attempts to reach the highest speeds of rotation: first, when it comes to the means of driving, and then there is the friction of the surfaces and the trouble in securing perfect centering or running balance. In experimenting in this direction astonishing results have been attained by Messrs. E. Henriot and E. Huguenard, as described in *Comptes Rendus.*

A motor was devised to be operated by compressed gas and with the rotating part supported by or cushioned upon the escaping gas—thus avoiding friction and at the same time making it possible for the rotor automatically to adjust its axis of rotation. A rotor 0.46 inch in diameter was maintained for hours at a speed of 240,000 revolutions per minute, and it could have been speeded up to 660,000 revolutions per minute.

TOY AUTOMOBILE DRIVEN BY COMPRESSED AIR

SOMETHING new in the way of a toy from England that is calculated to delight the average youngster is a miniature automobile which runs under its own power. The car, a racer-type model, is driven by compressed air—an air flask, secured to the bottom of the chassis, being charged with air at 100 pounds pressure. The air reservoir is built on the spiral-wound principle, and is suitably connected to a sturdy little motor in the body of the car. The engine is oiled by forced lubrication.

To start the motor, the driver releases the brakes by means of one of two levers on the outside of the car and slightly opens the throttle on the steering column—the speed of the vehicle being controlled by the throttle. The second lever makes it possible to reverse. By closing the throttle and by applying the brakes the car is quickly brought to a standstill. There are no gears to get out of order; and a special air pump is provided to charge the flask, which is of sufficient capacity to run the car for a quarter of a mile.



Canada now ranks third among the silver-producing countries of the world, being exceeded only by Mexico and the United States. Records of Canadian production have been kept ever since 1858. These records show a total recovery of 451,000,000 fine ounces to the end of 1923. In 1924, production was slightly in excess of 20,000,000 ounces. During 1858-1923 the value of silver production totaled $290,705,532, while for 1924 the output amounted to $13,519,043 worth of the metal.

The United States holds the premier position as a producer of refined oil. Although the United States provides 70 per cent. of the world's crude petroleum, last year we imported 77,840,000 barrels chiefly from Mexico. There are 300 active refineries in the United States, and in 1924 the output of gasoline totaled 8,959,680,000 gallons, the yield of kerosene was 2,521,109,000 gallons, the production of lubricating oils amounted to 1,154,927,000 gallons.

Galvanized corrugated sheets are extensively used in Siam for the roofing and the walls of rice and saw mills, factories, markets, halls of entertainment, fences, dwellings, etc. The use of this material has grown from 125 metric tons in 1918 to 5,063 metric tons in 1924.

The manufacture of artificial silk has reached splendid proportions. Enlargements of existing plants are actively underway, and several authoritative estimates place the 1925 output at more than 150,000,000 pounds—double that of the crop of natural silk.

A significant reflex of Japanese industrial development has been Japan's augmented demands for foodstuffs produced elsewhere. In 1908, Japan imported foodstuffs to the value of $34,000,000, while in 1923 the country thus obtained foodstuffs to the value of $125,000,000. Again, in 1908, Nippon imported $118,000,000 worth of raw materials, and in 1923 imports of this character totaled $678,000,000—representing an increase of more than 400 per cent.

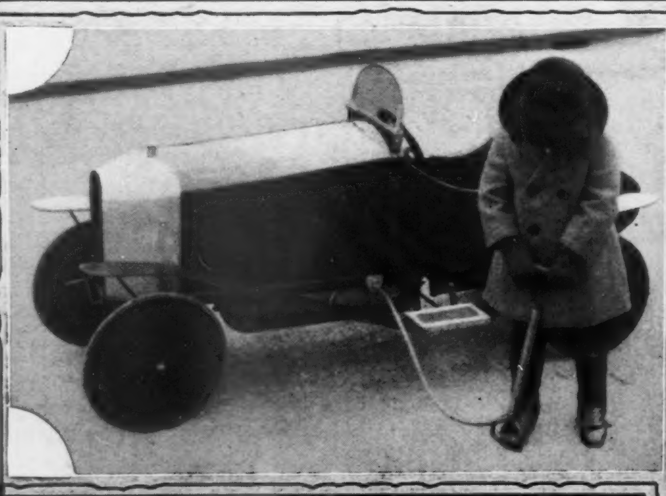
Canada still maintains its position as the leading foreign market for radio apparatus manufactured in the United States. According to preliminary figures for the first half of 1925, our exports to our neighbor increased to $665,287—being $209,917 more than the value of similar products sent there in the first half of the past year.

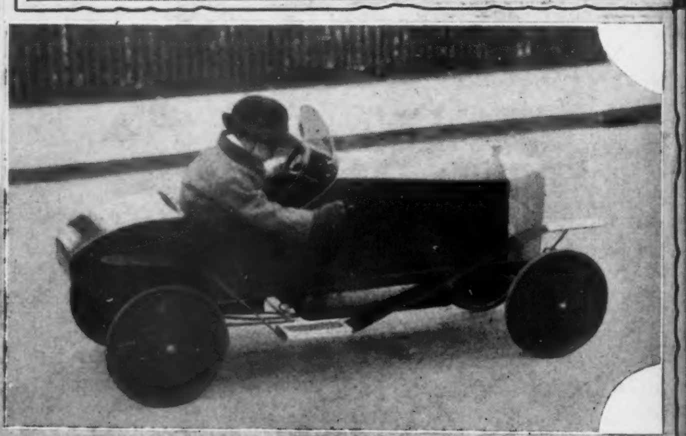
A Brazilian city council has passed a law appropriating something more than $400,000 for the purpose of extending the present intake pipe about a mile so that the city's water supply can be obtained more advantageously. This will involve cutting trenches for the main through two islands and providing necessary equipment for the chemical or ultra-violet-ray purification of the water.

According to figures compiled by the Copper & Brass Research Association more than 1,290,000,000 copper and brass parts, weighing all told fully 33,000,000 pounds, were in service last year in America's telephone instruments.

Rail motor cars are said to be well adapted to traffic conditions on many of the country lines of Victoria, Australia. According to a report made by the Railway Commissioners of that state, the average running time has been increased from 10 or 12 miles an hour to 20 or 25 miles an hour. Operating costs have been reduced in some cases, while in other instances improved service has been provided without an increase in cost. The fuel used is benzol manufactured in Australia.

About 25,000,000,000 bolts, nuts, and rivets having a sales value of $187,000,000, are produced in the United States annually.





This smart little car, complete with windshield, Klaxon horn, and all the appurtenances to delight a child, is driven by compressed air.

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